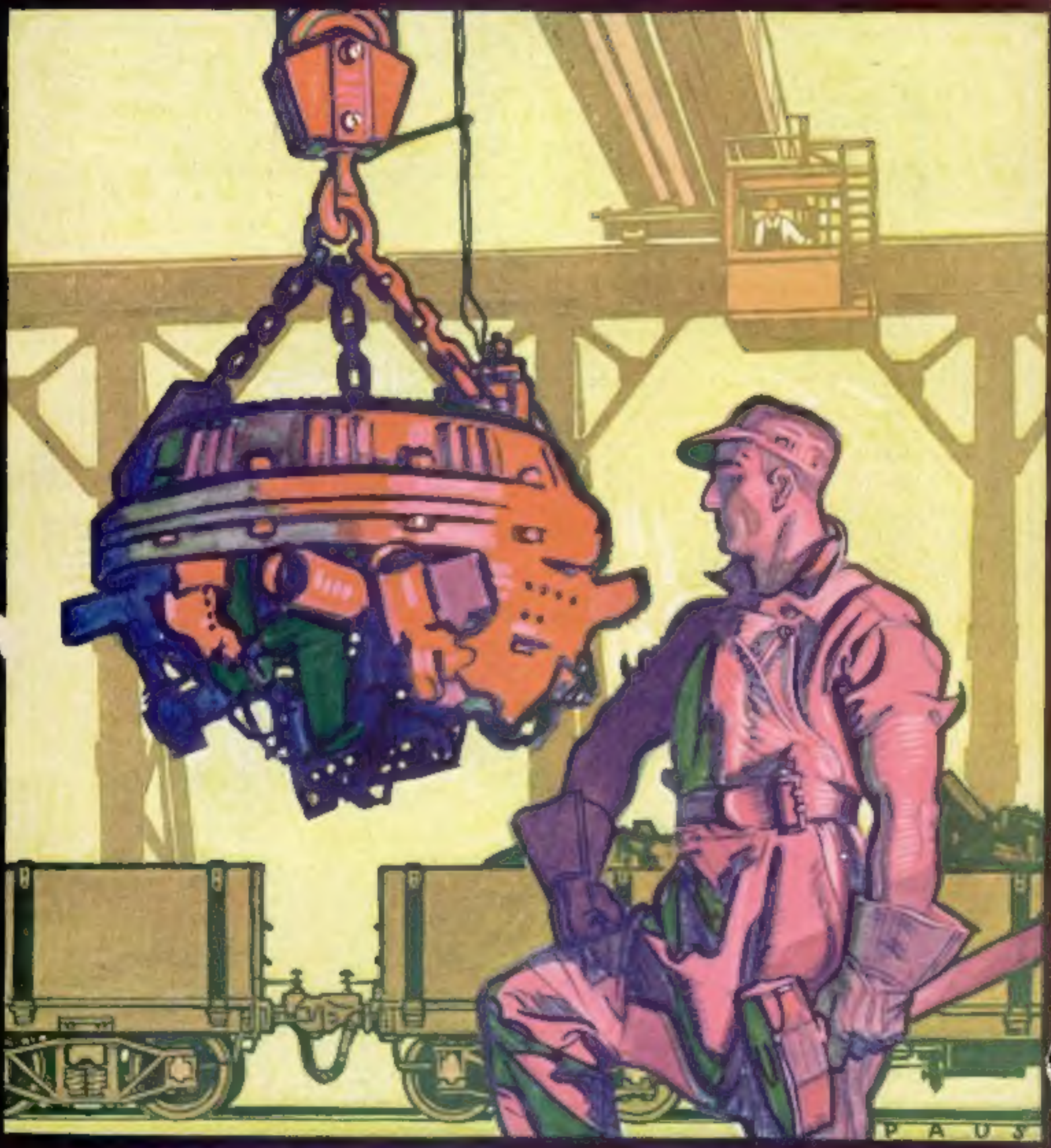
Popular Science

MONTHLY Founded 1872

June
1928
25 cents



In this Issue

Famous Pilots Tell How You Can Break Into Aviation

The *best* gasolines become *better* when ETHYL is added

RACING car drivers *can't* take a chance with their engines.

Before a race they test their cars with the best gasoline obtainable. Then they add "Ethyl" fluid—the anti-knock compound—to develop the last ounce of power for speed and safety.

Similarly, leading oil companies are adding "Ethyl" fluid to the gasoline produced for the general motoring public, so that your car too may increase its performance under all driving conditions.

This fuel is called Ethyl Gasoline and is sold at pumps which display the emblem shown below.

Read the facts about Ethyl Gasoline given below. Remember that even the best gasolines become better when "Ethyl" fluid is added.

Then give Ethyl a trial. Its price is merely the price of good motor gasoline plus the few extra pennies the "Ethyl" ingredient costs. But what a difference it makes in your car!

ETHYL GASOLINE CORPORATION
25 Broadway, New York City 56 Church St., Toronto, Canada

What Ethyl Gasoline is

ETHYL GASOLINE was developed by General Motors research to provide a more efficient fuel for internal combustion engines.

It is formed by adding Ethyl brand of anti-knock compound ("Ethyl" fluid) to selected motor gasoline in an amount sufficient to utilize the higher compression created by carbon deposits or advanced engine design.

"Ethyl" fluid is a concentrated liquid containing tetraethyl lead which has the property of controlling the combustion rate of gasoline. It is a patented product.

Only oil refining companies licensed to sell Ethyl Gasoline can mix "Ethyl" fluid with their gasoline. In every case the amount of "Ethyl" fluid must be sufficient to meet a definite standard of "anti-knock" quality rigidly controlled by the Ethyl Gasoline Corporation.

Ethyl Gasoline is colored red for identification. The color has nothing whatever to do with its performance. It takes more than dye to make "anti-knock" gasoline.

Ethyl Gasoline is sold only at pumps which display the "Ethyl" trademark.

Ethyl Gasoline is the yardstick by which other gasolines are measured.

What Ethyl Gasoline does

If your car is designed to operate on ordinary gasoline, the use of Ethyl Gasoline will:

Eliminate "that knock" and power loss.

Make carbon deposits a source of extra power. For carbon increases compression and Ethyl Gasoline is the high compression fuel.

Give a smoother and better pulling engine, particularly on hills and heavy roads.

Reduce gear-shifting and increase acceleration, thereby making traffic driving easier.

Cut down vibration, thereby reducing engine wear and tear and depreciation.

Save you the expense of carbon removal and other repairs caused by "knocking" and carbon formation.

Give more power per gallon for your fuel bills—and more mileage as compression is increased by carbon deposits.

If your car is a high compression car, just remember that Ethyl Gasoline made it possible and its use is necessary to obtain maximum performance.

In short, Ethyl Gasoline increases the performance of any automobile engine—whatever its compression—whatever the climate or other driving conditions.

LA SALLE

COMPANION CAR TO CADILLAC

CAR of cars, the La Salle, for those attuned to this new, vigorous day—for those who live life to the full. Brilliant in performance, it is built indeed for this breathless, brightly-colored age. A supremely great car because of the flawless coordination of the mechanism of its 90-degree, V-type, 8-cylinder engine—an engine without peer in any kind of going. A supremely beautiful and luxurious car because of its bodies by Fisher and by Fisher-Fleetwood.

1928 prices substantially lower on the entire La Salle line—from $2350 to $2875, f. o. b. Detroit. Five new models—including new five-passenger family sedan.

CADILLAC MOTOR CAR COMPANY

Division of General Motors Corporation

Detroit, Michigan Oshawa, Canada

WHAT IS NEW THIS MONTH

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June, 1928, Vol. 112, No. 6. Popular Science Monthly is published monthly at 250 Fourth Avenue, New York, N. Y., by the Popular Science Publishing Co., Inc. Entered as second-class matter Dec. 29, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Chicago, Illinois. Entered as second-class matter at the Post Office Department, Canada. Printed in U. S. A. Single copy, 25 cents. Yearly subscriptions to United States, its possessions, and Canada, $2.50; foreign countries, $3. The contents of this magazine must not be reprinted without permission. In presenting in its editorial columns numerous stories of new products of applied science, Popular Science Monthly does not underwrite the business methods of the individuals or concerns producing them. The use of Popular Science Monthly articles for quack-seller schemes is never authorized. O. B. Capen, President and Treasurer; R. C. Wilson, Vice-President; A. L. Cole, Secretary.

WHAT IS COMING NEXT MONTH

¶ How do trans-Atlantic flyers know when to hop off? They don't. But the weather man does. And the meteorologist who started Lindbergh, Byrd, and Chamberlin will tell in our next issue just what is the "right weather" for ocean flying.

¶ "I can peer into your stomach and read your future!" a famous physician recently told the editor of this magazine. And this doctor has written a remarkable article that tells how marvels of X-rays are solving mysteries of the human body.

¶ You can almost hear the spectators' shouts as the man who knows most about the world's greatest sporting event—the Olympic Games—predicts in a vigorous article the results of this summer's meet.

¶ Africa has a lure like that of no other continent. Strange people, strange animals, strange plants, and strange customs! "Now I'll Tell One About Africa" is an article that you won't want to miss.

¶ "R. O. G." to anybody interested in aviation means—"rise off the ground." So an R. O. G. model is one that takes-off like a real plane. A simple model of this type will be described in our Home Workshop Department.

¶ You will want to read, too, the next chapter of Commander Green's biography of that modest hero and sportsman, Richard E. Byrd, and the second installment of "Breaking into Aviation"—thrilling first-hand experiences of famous pilots.

AND leading articles that will tell the latest, up-to-the-minute news of laboratory discoveries, scientific triumphs, and amazing new inventions

GOLD
the 49'ers Overlooked

By WALLACE AMES, *Financial Editor*

IN THE days of the California gold rush one of the methods of mining was the sluicing process, whereby the water from mountain streams was flushed against gold-laden hillsides. The soil thus loosened was carried through a sieve-like contrivance which caught and held the precious metal.

But this process was outlawed as being ruinous to natural resources. Sluicing rendered the land useless for other purposes. It contaminated the streams and deposited a murk on the agricultural lands in the valleys. In consequence, many sluice miners left their claims and took up operations elsewhere.

Many years later a group of engineers explored what remained of an old sluice-way in the mountains east of San Francisco. They were locating a site for a great hydro-electric development. The sluice-way abandoned by the miners became the origin of what is now an expansive lake, Lake Almanor, in which water is stored for the use of a hydro-electric generating plant.

Thus engineers found a new kind of wealth in a deserted gold mining camp.

Until three or four years ago the Gatineau River, which flows through the wilderness of the Province of Quebec, was nothing more than a sportsman's paradise. Now, after you have trekked some thirty-five miles beyond the end of the railroad line you come upon a series of dams. They are part of a hydro-electric development serving power to paper manufacturers and other industries located many miles to the south. Wealth is being created in the wilderness.

THE engineering achievements of Lake Almanor in California and the Gatineau River in Quebec have been duplicated and multiplied many times over in the electric power and light industry. One of the many reasons why this industry has won its place as bed-rock security for investment is the fact that it is a *creator of wealth*.

By way of comparison, an automobile manufacturer or a construction company takes raw materials and adds to their value by making something useful; a railroad furnishes essential transportation service; a retail store supplies needed or wanted articles to its trade. An electric generating plant starts with nothing (one might say) and creates *new* wealth. It is a basic industry in the same sense as agriculture.

These are the days in which the achievements of science and engineering seem to know no bounds. Our imagination wilts under the spectacular advancement of aviation and radio. And we are still amazed at the way the demand for automobiles continues to shatter all prophecies with reference to the saturation point. Electric power and light development is more in the background than some of these other modern achievements. It does not dominate newspaper front pages. Service is so smooth and has become such an essential in both business and domestic life that we are apt to take the industry more or less for granted. Few of us realize what is actually going on. Yet in point of accomplishment the electrical industry is almost in a class by itself. The fact that the national wealth of the United States has more than trebled in the last twenty years is due in no small measure to the *creative* nature and the tremendous advancement of the electrical industry.

The story of the electrical industry is a story of continuous growth in periods of depression as well as in prosperous times. The very nature of the industry makes it grow. Our modern life could not exist if it did not grow.

JUST so long as our population continues to increase, the demand for electricity will increase. But, as shown in detail in an earlier article in this series, the power and light companies have not depended alone upon increased population for an increase in their business. The utility companies and the electrical manufacturers have greatly stimulated the growth of the industry by creating new uses and new demands for electric current.

Barely forty years old, yet over ten billions of dollars have been invested in the electrical industry. Less than fifteen years ago the combined capitalization of power and light companies was but a little over two billion dollars. In 1920 it was slightly under four and a half billion. Since then new investments in public utility securities have averaged over three-quarters of a billion dollars a year so that the combined capitalization of utility companies in 1928 is some ten and one-half billions—nearly five times what it was in 1912.

What is being done with the wealth in the form of electricity that is being created on the site of the abandoned California gold mining camp, in the northern wilds of Quebec and everywhere throughout the length and breadth of the North American continent? It is being sold to an ever-increasing number of users. In the United States alone the number of customers of the electric power and light industry has increased in fourteen years from 3,837,518 to 22,950,000.

How is the new capital that is being raised annually by public utilities being used? To take care of the continually growing demand for electricity a stupendous and never-ceasing program of building and expansion is going on. *Electrical World*, *(Continued on page 6)*

Gold the 49'ers Overlooked

(Continued from page 4)

which publication supplied the other statistics used in this article, gives the following figures representing annual expenditures for additions and extensions to power and light properties.

1921	$522,408,000
1922	524,016,000
1923	602,143,000
1924	692,440,000
1925	721,300,000
1926	841,344,000
1927	760,353,000
1928	900,363,000*

*Estimated.

(Continued on page 6)

Gold the 49'ers Overlooked

(Continued from page 4)

With the exception of the year 1927 the new building program of the utilities has increased each year. The slight decline in 1927 over 1926 simply means that some construction work has been delayed and the building program for this year must be all the greater.

How is this program of continual expansion financed? Being a *public utility*, a power and light company cannot charge rates which would permit large profits and the creation of a great surplus. Thus the expansion program cannot be financed out of earnings. To a greater extent than applies to manufacturing and commercial enterprises, public utility expansion and development must be financed through bond and preferred stock issues. Because the industry is always growing, and outgrowing its plant facilities, the power and light companies are constantly bringing out new issues of securities.

FINANCING the needs of public utilities has become a highly specialized business in which our leading investment bankers are engaged. These bankers maintain their own corps of technicians who conduct the most elaborate studies. Just one study of a Michigan company, that preceded a new piece of financing, occupied a volume of original data over two inches thick.

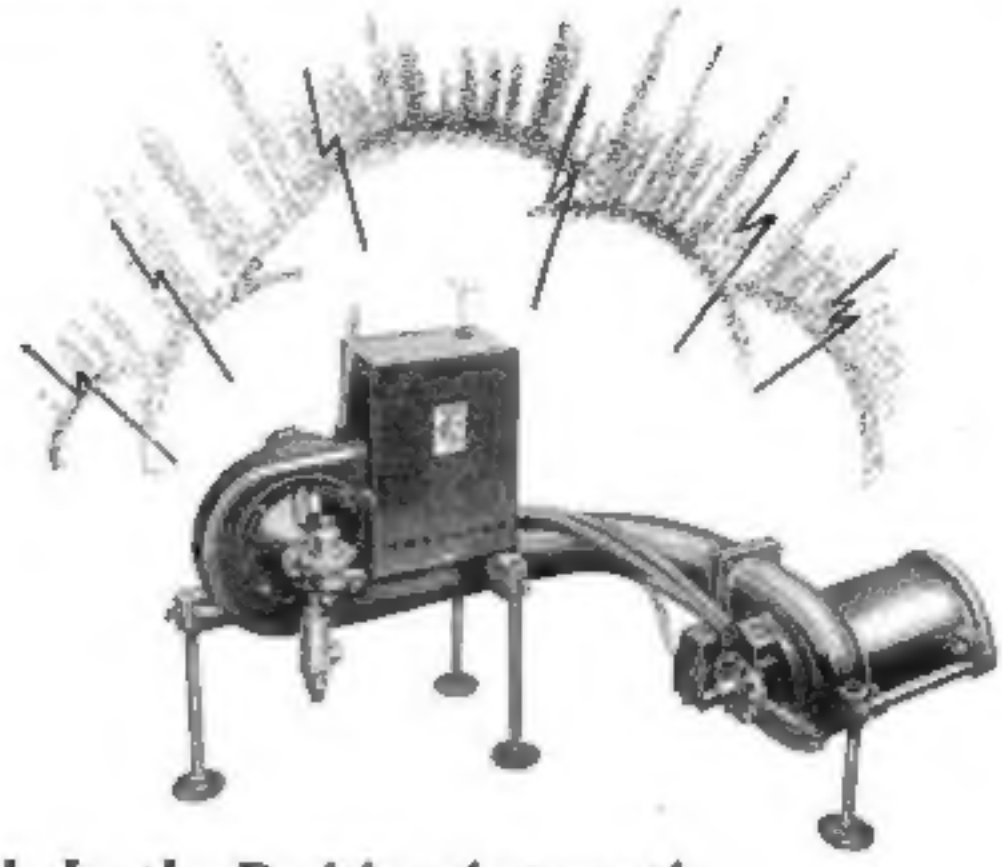
Every conceivable factor and phase is weighed and analyzed before a new bond or preferred stock issue is planned. Before a utility can market a new security issue, its earnings must show a satisfactory ratio to total interest and dividend requirements and property value must be in safe proportion to the total amount of securities to be outstanding.

That is to say, the standard practice of investment bankers is to surround all new issues of public utility securities with formidable safeguards.

THE conservatism with which life insurance companies make their investments is a matter of general knowledge. It is significant to note that twenty-five leading companies increased their proportion of public utility investments from about 8 to 20% of all their bond investments within a five-year period. The New England Mutual holds 30.5% of its bond investments in utility issues; Phoenix Mutual, 46.3%; Connecticut Mutual, 39%; Sun Life of Canada, 52.3%; Connecticut General, 67.6%.

Readers of POPULAR SCIENCE MONTHLY have a great variety of public utility securities to choose from. The leading investment bankers offer bonds and preferred stocks to suit every conservative requirement and to fit the individual circumstances of any investor. Or it is possible to invest direct in the preferred stock of the local public service company.

Most of them number a considerable percentage of customers among their stockholders.



Oil Heat at its Best

— is Made Possible by the Positive Automatic Electric Ignition of Electrol

Positive automatic electric ignition has always been a vital feature of the Electrol Automatic Oil Burner.

The oil, broken up into a fine mist-like spray is ignited by an electric spark, similar to the method used in the automobile engine. In the latter, however, the gas is compressed and exploded, whereas, in Electrol, the oil is mixed with air and is burned in suspension, producing the maximum amount of heat.

The thousands who enjoy the comfort and conveniences of Electrol doubly appreciate the certainty of its electric ignition — an advanced principle which makes Electrol entirely self-acting and automatic. Here, truly, is oil heat at its best.

Electrol employs electricity throughout. A small electric motor furnishes the power. An electric thermostat maintains uniformity of temperature. And over all, The Master Control stands watch, timing the ignition, regulating the flow of oil, governing combustion and providing a never failing, entirely automatic check on every operation.

With such control you can leave your house for an evening or for a month, with full assurance that the temperature will be kept uniform and that your home will be comfortable upon your return.

Quiet... Economical... and Entirely Automatic, Electrol will give you a new conception of how dependable an oil burner can be.

Wherever Electrol is sold you will find a complete oil heating service, backed by a sound, large and growing manufacturing organization. Electrol is made in sizes for every type of building, large and small. Purchase can be arranged in convenient payments if desired.

A few of the many thousands of Electrol owners

GEORGE P. BALDWIN
Vice Pres., General Electric Company, Greenwich

RUSSEL E. GARDNER, Jr.
President, Gardner Motor Company, St. Louis

ALFRED KNOPF,
Publisher, New York.

WILLIAM SKINNER,
Skinner's Silks and Satins, Holyoke.

Send for literature. Write today for a copy of "The Master Furnace Man," a booklet which will serve as an enlightening guide in the selection of an oil burner for your home.

ELECTROL INC. of MISSOURI
150 DORCAS STREET ST. LOUIS, U. S. A.

ELECTROL

The OIL BURNER *with The Master Control*

LISTED AS STANDARD BY THE UNDERWRITERS' LABORATORIES, AND BEARS THEIR LABEL

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

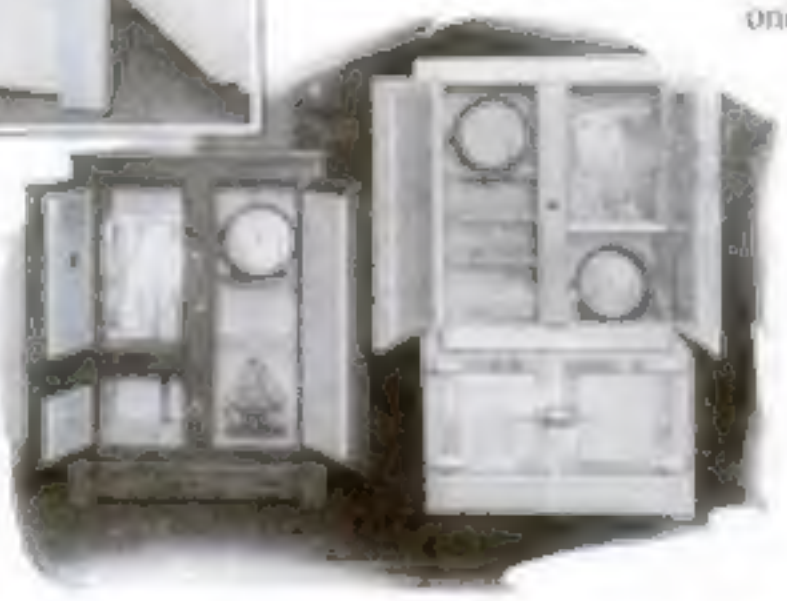
What *Good* Refrigeration Costs

The Popular Science Institute Aids You in Selecting an Efficient Refrigerator

By Professor R. D. Morrill

Testing Staff
Popular Science Institute of Standards

The automatic refrigerator on the left is being arranged for test to determine dampness left in box after hours of use. It might seem that finish and size were the two principal features of construction in which the boxes in the lower picture differ. The Institute's tests proved, however, that only one was capable of maintaining a temperature that would properly preserve food



TO KNOW that you have inadequate refrigeration is one thing; to know how to go about remedying the condition is another.

From Dr. Damrau's articles in this and previous issues of the magazine, Popular Science readers already know that the vast majority of American homes do not have adequate facilities for properly preserving food. Now such a condition would not exist in so many otherwise well equipped homes if the owners knew about it and knew what to do about it. Popular Science Monthly aims, therefore, to do something more than just point out an evil condition—it aims to offer concrete assistance in correcting the matter.

In this regard, the magazine is able to do two things. It maintains a free service to readers whereby they can get specific recommendations of good refrigerators, both ice and automatic types. It protects readers by excluding from Popular Science Monthly the advertising of any poor refrigerators. This means that every refrigerator you see featured in the magazine affords a means of adequate food preservation.

Of course, there would have to be a sound basis for determining what refrigerators are good, and the tests of the Popular Science Institute of Standards conducted in the Sage Research Laboratories at New York University offer such basis.

In these tests, The Institute finds out definitely the essential points regarding a refrigerator. A refrigerator must do more than be an attractive kitchen cabinet capable of holding the family food; it must *refrigerate* and refrigerate properly.

Despite the fact that so few refrigerators in actual use are efficient, this is not due to any scarcity of good makes for a number of the refrigerators that The Institute has tested have been found to be satisfactory in every way. For the guidance of readers of Popular Science Monthly, a list has been prepared specifying these particular refrigerators (automatic and ice types) that have been found to be both efficient and economical in operation.

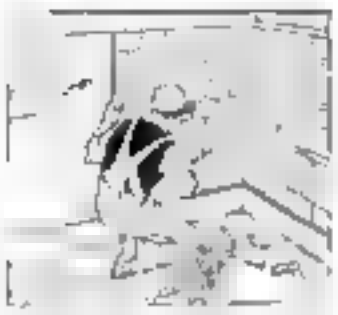
This matter of economy is something that deserves special attention from several angles. It has become a general rule that, in buying any type of equipment, whether it be a house, a car, a radio, or anything else, that once one goes beyond certain average price bounds, the investment becomes a luxury and both the benefits derived and the upkeep necessary come in the luxury class.

With refrigeration at the present time, this rules does not hold—in fact, the opposite is true. In the first place, the amount usually considered an "average" expenditure for this type of equipment is not sufficient to secure adequate refrigeration. Secondly, the average householder—even doubling his present outlay to get proper refrigeration—will be practicing economy because of the saving on doctor's bills through good health and saving on food bills through avoidance of spoilage. And, in the third place, the better the refrigerator the lower will be the operating cost, as proved by the Institute of Standards' test.

For readers who want full data on refrigerators, their selection and care, The Institute has prepared a 22-page booklet entitled "Refrigeration for the Home." There is a small charge for this of 25 cents. A complete list of the various refrigerators which are approved after test may be had free by writing the Popular Science Institute, 250 Fourth Ave., New York, N. Y.

Where will this *grainless* wood be used next?

First produced two years ago. Now standard material in an ever-widening range of industries. New uses being discovered almost every day. Send for large, free sample, and put it to the test yourself!



TILE FOR BATHROOMS

Ever since the dawn of history, man's favorite material has been wood. Surely, it was assumed, this wonderful product of nature herself could not be improved. Yet two years ago, this seeming miracle was actually achieved, and there went forth into the world Masonite Presdwood—a genuine all-wood board that won't crack, check, split or splinter; in fact, a *grainless* wood!

Nor is that all. Presdwood possesses remarkable workability and uniform strength. Very dense and tough, it is also highly resistive to moisture. It has a very smooth, attractive surface on the face side, and requires no paint for protection. It takes any finish beautifully.

Because Presdwood contains no grit or foreign substance, it does not damage tools. It can be used on any woodworking machinery: saw, planer, sander, shaper. It can be cut out, punched, die cut and milled.

And when we say Presdwood is *all wood*, we mean just that. It is genuine wood and nothing else—wood torn apart and put together again.

The first step in the manufacture of Presdwood is to explode fresh, clean chips from guns at a velocity of about 4,000 feet per second. The long fibres thus produced are then thoroughly felted together in heavy mats placed in hydraulic flat-bed presses and subjected to hundreds of tons of pressure. The finished product is trimmed to a four-foot by twelve-foot size.

We don't know ourselves

We don't know ourselves where this grainless wood will be used next; nobody does. Its workability and adaptability are truly astounding. For such things as paneling of all kinds, store fixtures, outdoor and indoor advertising signs, and a hundred and one products of planing mills and woodworking plants, it is already in very wide demand. It is also winning permanent acceptance as the ideal lining for bank vaults, telephone booths, ventilator shafts, closets and trunks. Thousands of feet of it, too, are used in making movies and for incubators, packing cases, tension boards, radio boxes and starch trays for candy factories.

But did you know that a contractor out in California is using Presdwood for concrete forms? Did you know that quite a number of boats have been made of it almost entirely? Did you know that it makes an excellent flooring for dance halls and pavilions, and that it is in daily service at the Chicago Art Institute as artist's boards. We certainly didn't—at least until a few short months ago.

FOR INCUBATORS

* * *

And week after week we hear of new uses! Just recently a manufacturer of bowling alleys became interested in Presdwood. Another unexpected demand is its use as shutters for Dutch Colonial Houses. It is also being made into clothes hampers, bread boxes, patented dairy containers, barbecue stands, bedroom screens and invalid trays.

Where will this *grainless* wood be used next? Nobody knows. For its range of adaptability seems to have almost no limit!

Send for sample—try Presdwood yourself

Users of Masonite Presdwood—and there are now thousands of them!—have found that it often effects marked economies; such as doing away with the expense of painting, reducing the number of manufacturing processes, and eliminating waste in cutting. They have found, too, that it is very easy to work with, and that it is entirely free from knots and other defects.

Why not put Presdwood to the test yourself? It may be exactly the material you are looking for. It may make it possible for you to improve your own product in a number of worthwhile ways or to cut down your operating costs. Or both.

In any event it will cost you nothing to find out. For we will gladly send you a large sample of Masonite Presdwood without placing you under any obligation. Send for it today.

MASONITE CORPORATION

Sales Offices: Dept. 1268, 111 W. Washington St.

Chicago, Illinois

FOR ADVERTISING SIGNS

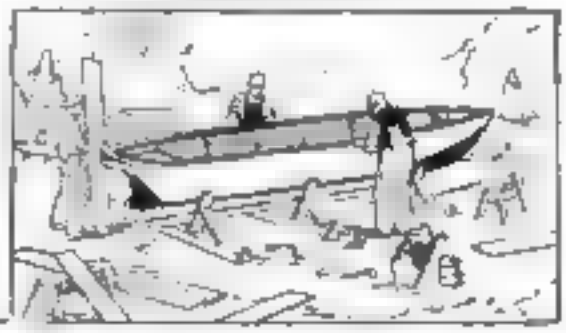
Mills: Laurel, Mississippi

Masonite PRESDWOOD

Made by the makers of

MASONITE STRUCTURAL INSULATION

IN BUILDING BOATS

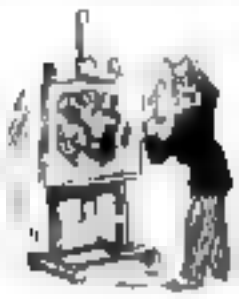


Our Readers Say—

Thoughtful Mr. Paus

"AM GLAD Mr. Paus, your artist, explained in his article what the cover picture on your May number was all about. Otherwise we might be guessing yet."—K. D. V., Topeka, Kans.

"I am delighted with the very decorative covers by Paus on POPULAR SCIENCE. They are wonderfully effective, while preserving the necessary mechanical details. In a long life among artists I have found that many of them are possessed of more mechanical knowledge than the man on the street gives them credit for."—E. T. Bearsville, N. Y.



"It would be hard indeed to say which part of POPULAR SCIENCE MONTHLY is most interesting, as every article contains something of value to a person interested in mechanics or science. I think the fiction stories help to make the magazine better, if possible."—A. W. R., Oskaloosa, Ia.

"The magazine is deteriorating since you included fiction. The stories are poor especially where women are included, as in the 'Movie Maker.' One scientific article on that subject would serve better."—C. R., Reardon, Wash.

Fool or Hero?

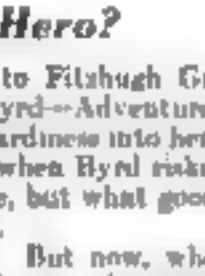
"MY ONE objection to Fitzhugh Green's story of "Dick Byrd—Adventurer" is that it tries to turn foolhardiness into heroism. Of course I was thrilled when Byrd risked his neck over the North Pole, but what good was it? He found a lot of ice.

"That wasn't so bad. But now, when he takes the pick of college boys and trains them to face starvation and death with him on a trip to the South Pole, I want to protest. This isn't anything heroic. It's little short of criminal. What will he discover? A lot more ice—of no earthly use to anybody.

"Nevertheless, I must say that Green's story has gripped me, and I am glad enough to have my boys read it. Soft men who always play safe are common as sand. The Dick Byrds are scarcer than diamonds."—A. L. M., New York.

Was Elinor Right?

"ALL this advertising twaddle about knowledge making a good conversationalist is the bunk. I have read your valuable magazine a long time. I have spent all my spare time for twenty-five years reading good books, including Dr. Eliot's Five-foot Shelf. I have studied all the religions of the world. I know algebra, trigonometry, logarithms, geometry, etc. I have studied physical culture, chiropody, osteopathy, mental healing and medicine. I can converse in geology, physics, astronomy, chemistry, biology, zoology, evolution, the fourth dimension, socialism, anarchy, single tax, tariff, ethics, logic. I know half the fossils by their first names. Have studied all the branches of photography, made church windows, studied electricity. I understand a slide rule. I have been around the world, spent a week in San Francisco, nine months in Texas, a year in Atlanta, four years in Springfield, O., three months in Chattanooga, Tenn., six in Savannah, Ga., fifteen in Florida—all since I was eighteen years old. I have written four moving pictures (and never sent them in) built three houses by myself without any helper but my wife, learned how to dance (but never go), took two courses in public speaking, and a lot more things.



"And still, after all this, I can't interest anybody with my talk. I am firmly convinced there is only one thing that makes anyone popular and that was explained by Elinor Glyn—'IT.'"—J. E. N., Tampa, Fla.

But It Saved Marian!

"THAT story of 'The Electric Pilot' in your May number is fiction, all right. It is true, as you say, that push-button control of airplanes has been tested. The only trouble is, it won't work. To be a good flyer you have to have the feel of the machine, and every one of your movements becomes second nature, like swimming or riding a bicycle. Think what it would be like if you had to press certain buttons to ride a bike! Well, the same thing is true of an airplane. I happen to be a flyer and know what I am talking about. For all that, I liked the story. Give us some more as good."—E. B. M., Dallas, Tex.

We Second the Motion

"PLEASE," writes J. B. D., of San Francisco, "add this to your 'What's Wanted' book:

Plates, knives, forks, spoons, cups and saucers made out of material cheaply enough to be thrown away after each meal instead of being washed and wiped. This would be a boon to tired husbands who don't play bridge.

Friends Worth Knowing

"A FRIEND left a dozen copies of POPULAR SCIENCE MONTHLY at my home a few months ago and I am living in a new world. I take much interest in the mechanical news, the machine shop and Old Bill, as you call him, and his proverbs, and his ideas of doing things that other machinists pronounced impossible, such as cutting a thread on a twelve-inch pipe that was bent at right angles, and removing a crank from a steel shaft that had been shrunk on.

"I am getting quite well acquainted with Old Bill and Grimes and Harvey, and I like them very much, for a man that can teach me something is always an interesting person."—A. K. S., Richmond, Maine.

But There's Jack Dempsey

"IF YOU want my honest opinion," writes J. J. B. of Springfield, Mass., "the house that had its face lifted in your April number was much better looking before the 'lifting' process began. It is always the same. Once I was inspired to put an eyebrow window in the front of my house. The result was a one-eyed monstrosity. Will housebuilders and women never learn to let well enough alone?"

"Mr. McMahon's articles on housebuilding have given me the best fun of my life," postcards A. G. R., Boonton, N. J. "Thanks to some of his suggestions, I have just turned an old stable into an attractive summer home."

A "Duffer" Learns to Drive

"HAVING raised five blood blisters and shocked my wife, I finally got a carpenter to show me how to drive a nail. I was surprised to find the trick is much like driving a golf ball. Grip the end of the handle, keep your eye on the head, which in this case is the head of the nail, and swing with an effortless "follow through" stroke. Always before, I tried to pound with short pushing strokes and half the time I pulled, shoved or missed altogether. Now hammering has turned out to be fun, and every nail goes into the hole for a par four. I am writing now to suggest that you might help us duffers a lot by giving us a few elementary lessons in Home Workshopping, hammering, sawing, planing, chiseling, etc."—D. B. S., Duluth, Minn.

Well, There Are Two Sides—!

"ALLOW me to suggest that you have discovered a mare's-nest in the family icebox. The assumption of the writer of "Dangers that Lurk in the Family Icebox" is that a refrigerator is bought for the purpose of killing putrefactive bacteria in food. In that I believe he is wrong, as only incidentally does it act as a bacteria killer or inhibitor.

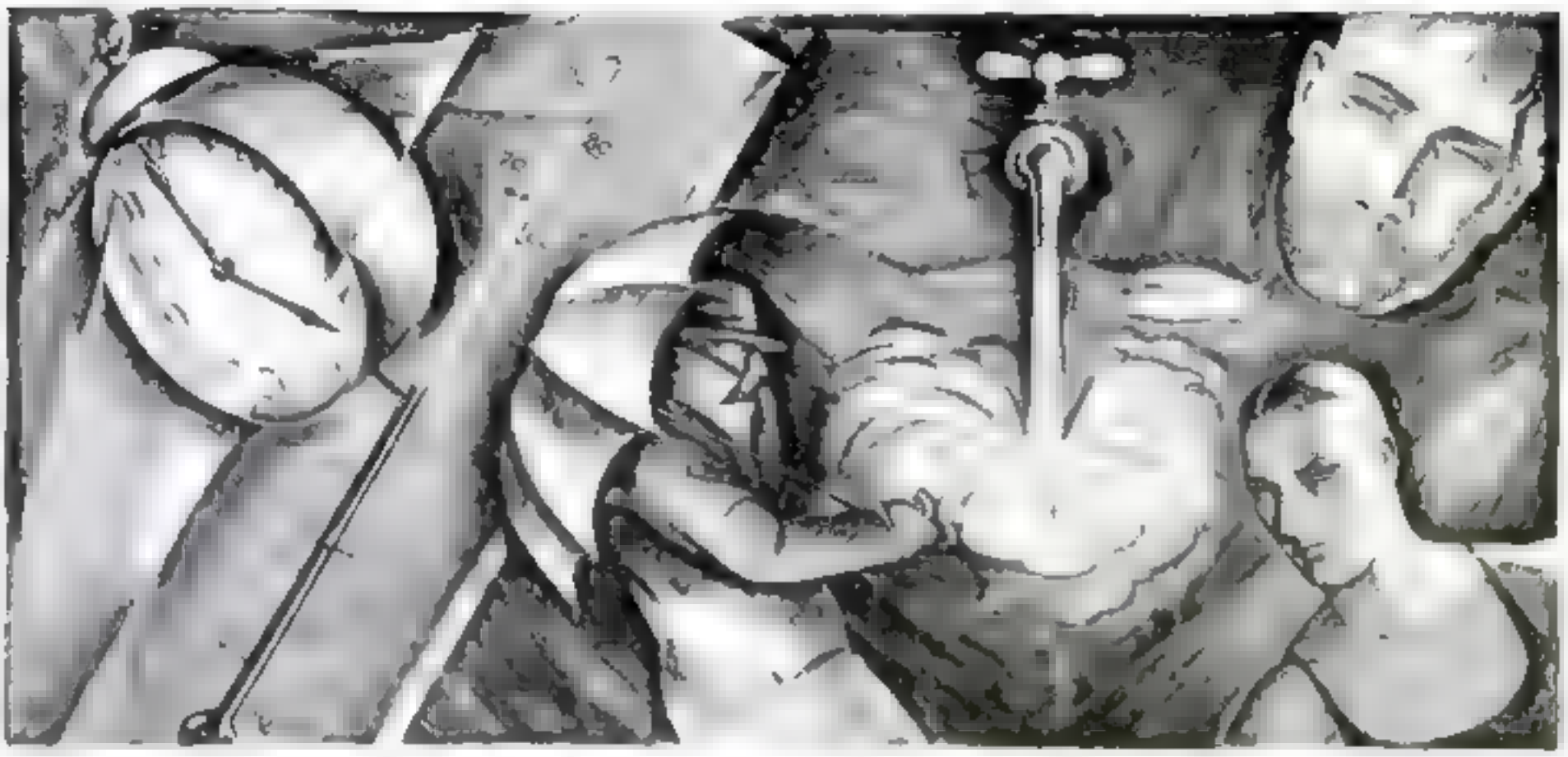
"Your writer entirely overlooks the fact that food, after it is removed from the icebox, is almost always heat treated, and any harm-producing microbes are thus killed. Our icebox at present contains eggs, roast meat, corn, cheese, bacon, milk, butter. All are heat treated before consumption except cheese, milk and butter. The salt protects the butter; milk is consumed the day received, and cheese simply dries out."—G. H. T., Philadelphia, Pa.

"Congratulations on your activity in the investigation of the household icebox. This is a subject that is very important, and the pity of it is that your circulation is not ten times as great so that all might learn of the menace of the warm icebox."—G. J. Z., New York City.

A Ship for a Car

"YOU may be interested to learn that I am one of the fortunate ones to finish a Spanish galleon as per your blueprints, and having finished it I traded it in for a closed car, 1925 model, valued at $600. And now I shall make another galleon for the home."—E. T. S., Chicago, Ill.

"I was much gratified to find, in leafing through POPULAR SCIENCE MONTHLY, the first of your four articles telling how to construct the *Mayflower*. Frankly, I will say that though all of your preceding models interested me immensely, none caused my hand to actually itch for a tool as does the *Mayflower*. The only thing that keeps me from starting to build it immediately is the fact that I am in the midst of constructing your fine model of the Pirate Galley."—W. R. A., New York City.



TIME · TEMPERATURE · HUMIDITY · WATER BEARD · SLEEP · SKIN CONDITION HEALTH · NERVES · LATHER

Gillette must do a different job for you each day

—*with a blade which does* all *of them superbly*

THE weather may be fair or foul, warm or freezing; the water may be hot or cold, hard or soft; your digestion, too, affects the comfort of your shave; so do your nerves —how well you slept, and how long you lather.

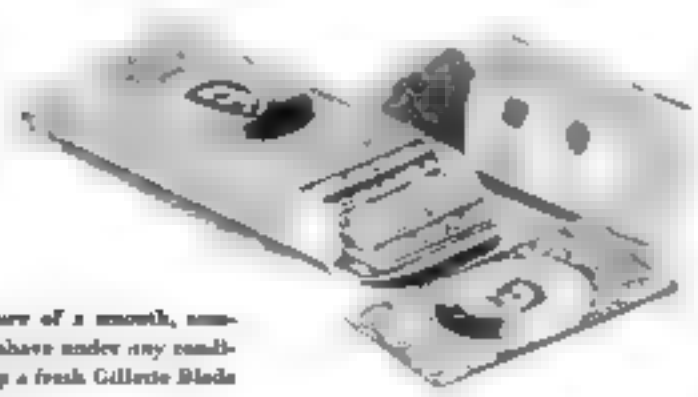
There are at least forty different reasons why your Gillette Blade never gets precisely the same kind of shaving job to do twice.

There is just one reason why you can always get a smooth, clean, comfortable shave under any conditions—the invincible, even-tempered smoothness of the Gillette Blade—the one *constant* thing about your daily shave.

Gillette could safely make this statement in the beginning when the daily output of blades was less than a hundred. We can make it now with far greater positiveness, when over two million perfectly honed and delicately stropped Gillette Blades leave the plant every day. For these blades are made by delicate machines adjusted to one ten-thousandth of an inch. Human skill could never hope for such accuracy. The blades receive most rigid inspection at every step. To make this possible, four out of every nine employees are skilled inspectors who actually receive a bonus for every blade they discard.

When you slip your fresh Gillette Blade into your razor tomorrow morning, remember that it has a different job to do each day—and does it with comfortable smoothness.

GILLETTE SAFETY RAZOR CO., BOSTON, U. S. A



To be sure of a smooth, comfortable shave under any conditions, slip a fresh Gillette Blade in your razor.

Gillette

Gillette

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Get it *Better* with a Grebe

Ease of operation—simplicity, as simple, indeed, as the signals which played so important a part in the birth of our nation; that is naturally expected in any A-C (alternating current) light-socket operated receiver

But the Grebe Synchrophase A-C Six offers far more than mere ease of operation; far more than relief from bother with batteries.

In addition to the convenience of light-socket operation, you have freedom from A-C hum (so annoying in many A-C sets), incomparable tonal beauty, range and selectivity, and exclusive Grebe improvements resulting from nineteen years of outstanding leadership in the radio field.

Grebe Synchrophase Seven, $145; Grebe Synchrophase Five, $105; Grebe Natural Speaker, $35; Grebe No. 1750 Speaker, $17.50.

A demonstration of the Grebe Synchrophase A-C Six will convince you of its superiority. The features of this new receiver are fully explained in Booklet P, which we'll be glad to send you.

GREBE SYNCHROPHASE

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Makers of quality radio since 1909

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Popular Science MONTHLY

JUNE, 1928 SUMNER BLOSSOM *Editor* VOL. 112, NO 6

Breaking Into Aviation

An Article by EDGAR C. WHEELER, Who Asked Every Licensed Pilot in the United States to Tell of His Experiences in the *Flying Game*, How He Got Into It, and What He Thinks of Its Opportunities

TWO students of the New York University School of Aeronautics, Walter Hartung and Wilbert H. Steinkamp, are, at this writing, preparing to round out their course by flying from New York to Chicago!

More than a thousand other young men have just applied for entrance as cadets in the flying schools of the Army Air Corps.

A whole army of people today are starting into the thrilling and swiftly growing new industry of aviation. Just beyond the horizon they see opportunity for fame and fortune in a field as promising as was the budding automobile industry two decades ago. The rest of the world envies them, and who would not?

Almost everybody, these days, wants to fly. Every mail brings letters to the Editor of POPULAR SCIENCE MONTHLY, asking for advice on ways to get into aviation. And since the questions thousands are asking can best be answered by the men who are already in aviation, POPULAR SCIENCE MONTHLY asked every licensed pilot in the United States to tell our readers of his experiences—how he began his career, and how he reached his present position in the air. These men are commercial pilots, aircraft manufacturers and designers, executives of commercial air services, flying instructors, heads of aviation schools, aerial photographers, flying salesmen and advertising men, airplane dealers—in fact, they represent virtually every branch of the industry.

In this, and in a succeeding article next month, will be related some of the stories they tell, and the judgments they have formed after years of flying. Never before, we believe, has there been assembled such a remarkable volume of expert advice on aviation and its opportunities.

"Broke most of the time, and having narrow escapes from crack-ups."

That, from Pilot Arthur J. Davis of East Lansing, Mich., tells, in a nutshell, of the early struggles of most of the flyers who have made good. That was the story of Lindbergh and Chamberlin and a host of others.

There, for example, is Nick Mamer, a former Army pilot who made a name for himself in Uncle Sam's Aerial Forest Fire Patrol, and who was third place winner last year in the New York-Spokane Air Races. When, in 1919, Mamer was discharged from the Army Air Service, he was an expert pilot, who as a boy had launched miniature gliders. From pioneers of the game in California he had received his first training.

But now, to his surprise, there was no position to be had. For a month he searched in vain. Then the manager of a flying company showed him a huge pile of parts of disassembled war planes and said, "If you can make a plane out of this junk I'll give you a chance to fly."

"Fair enough," said Mamer, and in a few weeks was cutting the sky with breath-taking loops, rolls and other stunts that only a war-time pilot knew.

After wearing out the plane with two years' exhibition flying in the Middle West, he bought a machine and put in three similar years in the Pacific Northwest. He got the first private aerial fire

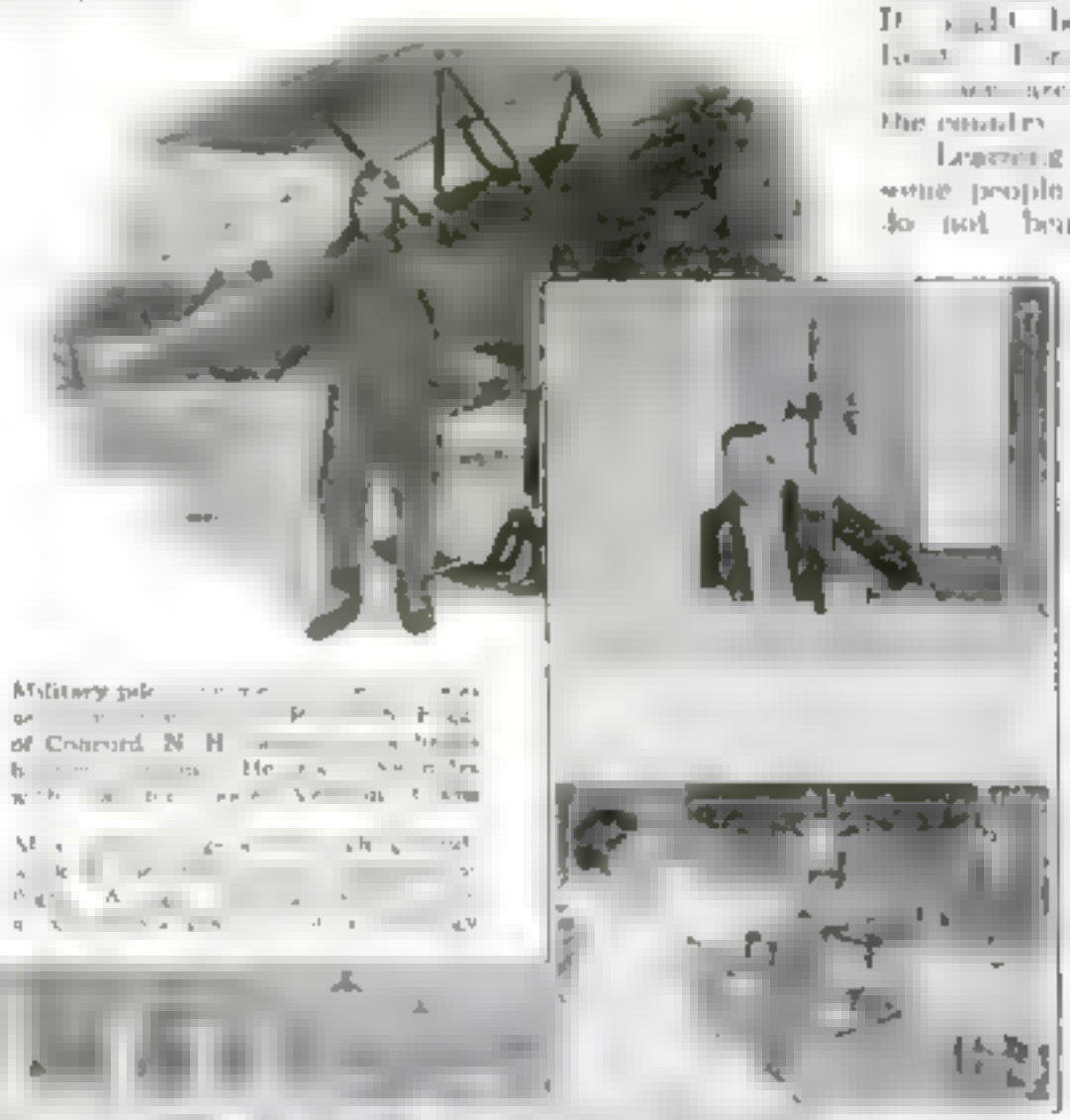
Ruth Rowland Nichols, woman pilot and aviation company executive who has made a notable success of commercial aviation. "I made my first solo flight in 1933," she says

patrol contract over timbered areas of Washington, Idaho, and Montana and achieved famous newspaper "scoops" by flying with photographs of the Dempsey-Gibbons prize fight, the Japanese earth [illegible] and the Amund[illegible] transpolar flight. For [illegible] has been senior pilot in the U. S. Aerial Forest Fire [illegible] stationed at Spokane.

Over timber and [illegible] he has carried approximately 12,000 passengers [illegible] 4,000 hours without [illegible] injury to them or himself. And today he has established his own flying [illegible].

[illegible] today [illegible] has a total [illegible] or more hours [illegible] the experiences of those who [illegible] and built up the business. Today [illegible] planes are safer and easier to fly.

[illegible] out of ten



Military pil[illegible] of Concord, N. H. [illegible]

One way to break into the game—as mechanic in an aircraft factory. This illustration shows the assembly of a giant Fokker plane fuselage in the Atlantic Aircraft Corporation plant, Passaic, N. J.

of the pilots, when questioned on the subject, warned young men against setting their hopes too high. Their advice, in effect, was this:

Aviation is like any other highly specialized business or profession. To reach the top you must learn from the bottom, and this takes time, study, enthusiasm, ambition.

If you think you can learn to fly in ten hours or so, then land a thrilling job in the air at a large salary, *don't try it.*

But if you are enthusiastic enough to spend two or three years learning the business, without expecting financial return, then *go to it.* The rewards are well worth the price you pay.

The first essential is a thorough groundwork in aviation theory and mechanics, you've got to know the machine you work with. The next is to learn to fly. The third is to get enough experience in the air to win a commercial or transportation pilot's license. The fourth is to apply your flying knowledge to profitable ends.

First, then, what is the best way to learn to fly?

Let's see how these pilots learned. Sixty-five percent were trained in the Army and Navy Air Services. Ten percent learned in civilian aviation schools. Others learned from private instructors. A few broke in as airplane mechanics or in aircraft construction plants, taking part of their pay in flying instruction; still others learned while working at odd jobs around flying fields; five taught themselves, and one was an aerial performer and parachute jumper who learned from his pilot between stunts.

The advice they offer to young men who want to fly follows largely their own experience. The majority judgment was best expressed, perhaps, by Walter McIl. Moore, of Louisville, Kentucky.

"IF YOU can afford it," he said, "take the full aeronautical course at some school such as the Massachusetts Institute of Technology or New York University, and in conjunction take a course at some good flying school. If you are not so fortunately situated as to finances, but have a good supply of 'guts' and the desire to get the best flying training in the world, apply for training as a cadet in one of the Army Air Corps flying schools. This is the toughest course known, but if a man can finish it he knows the game thoroughly. It might be termed the 'Lindbergh [illegible]' for the man who just wants to [illegible] good flying schools all over the country.

Learning to fly is not so easy as some people think, and consequently I do not believe flying will ever become as popular as motoring," said Wesley L. Smith of Cleveland, one of the most famous of Air Mail pilots. "Flying is becoming safer and easier every day, but it still divides all pilots into two classes: the quick and the dead. All records seem to show that only one man in ten thousand has the necessary mental and physical qualifications to become a successful flyer."

Among the few men who virtually taught themselves is one of the greatest of Army pilots, Maj. Herbert A. Dargue, who commanded the pick of the Army Air corps on the Pan American Good Will Flight about a year ago. He learned in early Wright planes in a few hours, when little was known of flying or instruction methods. Those daring and hazardous early experiments are not at all recommended to youths of today.

Another who had many narrow escapes [illegible] himself is John K. "Tex" [illegible] now a distributor of airplanes [illegible].

Back in 1911," he recalled, "I joined with a couple of other fellows in building our own crude plane and tried to learn. After a year of hard work and a good many 'crack-ups', I finally succeeded. Later I became instructor of flying in the Army.

Previous mechanical experience, particularly with automobiles, has opened

the way to the sky for many flyers. For instance, Ray Fortner, test pilot for the National Airways System at Lomax, Ill., who as a passenger paid $20 for his first air ride in 1920. "I might as well be making that money," he figured and, disgusted with unprofitable automobile racing, traded his car to a flyer for his plane and two hours' instruction. Soon he was carrying passengers. Luck was with him until his motor quit.

"That crash," he recalled, "taught me more than ten years' experience. Since then I've flown 2500 hours without injury to anyone."

Harry Rogers, head of the Rogers Air Lines, operating seaplanes between Florida and the West Indies and an air taxi service around New York, had this to say:

"My first experience was with a private owner who had taken a course of instruction. I played around with him in 1915 and 1916, learning to fly in the meantime. Being of a mechanical nature, I was familiar with internal combustion motors and the mechanical part came easy."

IN 1917 Rogers enlisted in the Naval Air Service as one of the first civilian instructors and for four years flew almost every type of military plane.

Incidentally, one of Rogers' pupils was Ruth R. Nichols, who is now a licensed pilot and director of general promotion for one of the largest aviation companies in the United States.

Basil Sims, now president of his own aircraft company at Bloomington, Ill., hung around a commercial field near his home, doing odd jobs for pilots who in return taught him to fly. While serving as aerial chauffeur, and teaching his employer to fly, Sims himself acquired the necessary experience to obtain a commercial license.

A few pilots learned in spare hours, while attending school or college. One was Fred E. Davis, now connected with a flying service at Columbus, O. He and a classmate at the University of Cincinnati obtained jobs with a newly formed aviation company, taking part of their wages in instruction.

"In this way," he said, "we finally received enough time to solo. After that the company gave us enough solo time to enable us to get commercial licenses."

Perhaps the record for speed in mastering a plane goes to Harold J. Forshay, of Dayton, O. He learned to fly in forty-five minutes!

"At the time I learned," he said, "the Air Service needed men and had to get pilots through in a hurry, so I was given only forty-five minutes—ten minutes' joy ride and the rest of solid instruction. I had never been in a plane before."

M. B. Freeburg, head of a commercial flying service at Shenandoah, Ia., began by purchasing a plane of his own and engaging a pilot to teach him.

"Without doubt," he said, "this is one of the best and quickest ways to learn."

After a man has learned to handle a plane, the problem of gaining necessary experience in the air is, most of the pilots believe, one of the most difficult problems he has yet to face.

"The quickest way," said Irwin K. McWilliams, a former Army pilot who is now an aircraft distributor at Brooklyn, N. Y., "is to buy your own plane and get instructions on it. Most of my students have their own planes and I believe it is the most satisfactory way of learning."

But airplanes are costly and there are less expensive solutions. John Miller, former Army pilot who runs a flying school at New Brunswick, N. J., says:

"Get a job as a mechanic's helper at a flying field or airplane factory, and, as opportunity offers, get in some flying experience, possibly as assistant pilot on one of the larger types of machines."

Joining a flying club at a cost of twenty-five to fifty dollars, and obtaining the use of the club plane for the cost of gas and oil, is a solution suggested by a number of pilots, and Capt. John B. Homberg, head of an aerial photographic service in Chicago, suggests:

"IF A young man has no money he can probably make arrangements with a reputable flying school to get his instruction at odd hours. This will permit him to work in the vicinity and earn the money to pay for his course as he [redacted]."

Here are other interesting bits of advice and comments:

"Yes, I'm the man that proved you can't fly through the woods."—Kellogg Sloan, Bolling Field, Washington, D. C.

"I flew alone before I knew how to fly. That's bad practice."—Edwin H. Bassett, Langley Field, Va.

"Take a comprehensive course in maintenance of planes before attempting actual flying. In other words, know what it's all about. Roy P. Applegate, Palm Beach, Fla.

"Select the man whom you wish to train you, investigate his ability as a pilot, also as an instructor, for there are many good pilots who are poor instructors. An apt pupil will become much the same flyer as his instructor."—Glenn E. Messer, Birmingham, Ala.

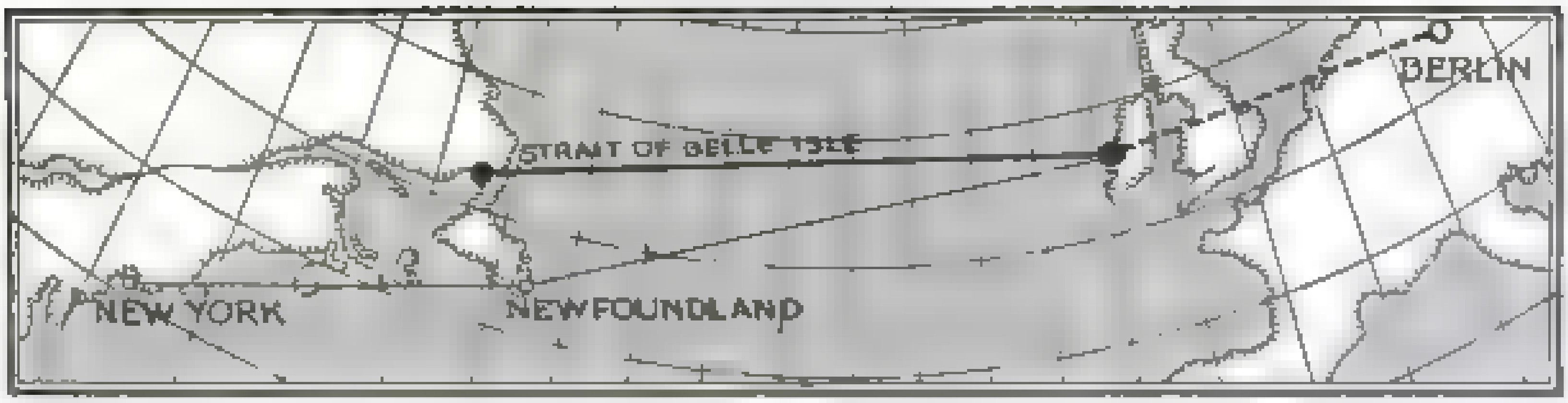
"Keep on the plow!"—W. C. Maus, San Antonio, Tex.

In another article next month the pilots will tell how they reached their present positions in the industry, and of the opportunities open to young men who are determined to fly.

"Get technical knowledge, then apply it practically," advises Harry Rogers, of Rogers Air Lines. Here he is instructing Miami high school students

Maj. Herbert A. Dargue (left), famous Army pilot and commander of the Pan-American Good Will Flight, virtually taught himself in early Wright planes. He is seen talking with Maj. Gen. M. M. Patrick, former chief of the Army Air Service

"Flying is not so easy as some people think; it still divides all pilots into two classes, the quick and the dead," warns Wesley L. Smith, famous Air Mail pilot of Cleveland, Ohio



First Plane *from* Europe

ACCEPTING a Challenge Which had Already Cost Seven Lives, German Plane Wings its Way to a Glorious Conquest when it Battles Through a Wall of Winds Over the Raging Atlantic and Lands Three Brave Flyers on the American Continent

By H. C. DAVIS

THE uphill sky trail over the growling Atlantic from Europe to North America has been blazed at last!

Struggling against bitter headwinds that seemed bent on flinging them back, plunging through storm and fog, three daring flyers in the single-engined Junkers monoplane *Bremen* completed the perilous east-to-west ocean flight, the Atlantic's greatest challenge. They have achieved what seven other brave aviators—five men and two women—gave their lives in a vain effort to accomplish.

When the *Bremen* with its crew of three—Captain Hermann Koehl, chief pilot; Col. James Fitzmaurice, and Baron Ehrenfried Gunther von Huenefeld—hopped from Ireland to attempt the westward flight, the world held its breath. Millions recalled the tragic fate of Nungesser and Coli in the *White Bird*; of Hamilton and Minchin and Princess Lowenstein Wertheim in the *St. Raphael*; of Hinchliffe and the Hon. Elsie Mackay in the *Endeavour*—all swallowed in the silence of the unknown. The Atlantic's challenge remained.

Then a radio message:

"German plane *Bremen* landed at Greenly Island noon today. Slightly damaged. Crew safe."

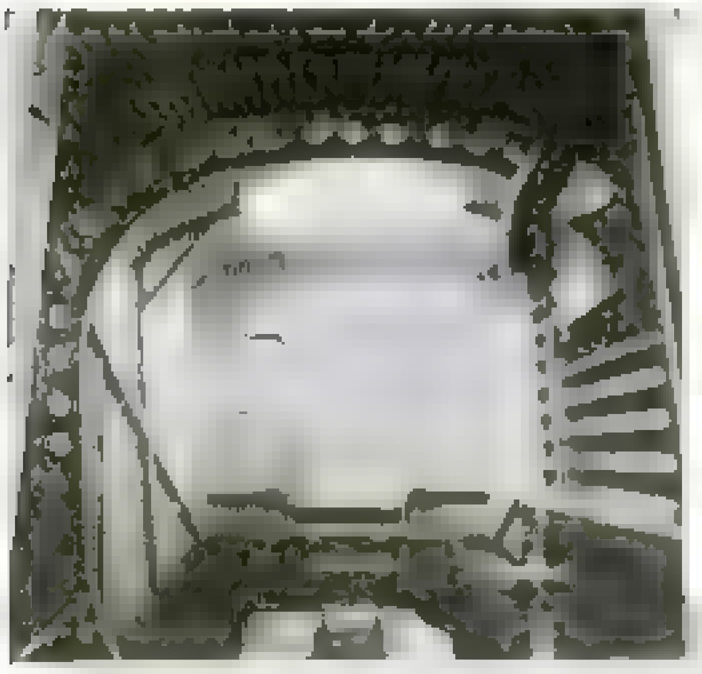
DRIVEN [illegible] miles off their course [illegible] and [illegible] they were safely across! They had flown for nearly thirty-five hours, covering 2300 miles!

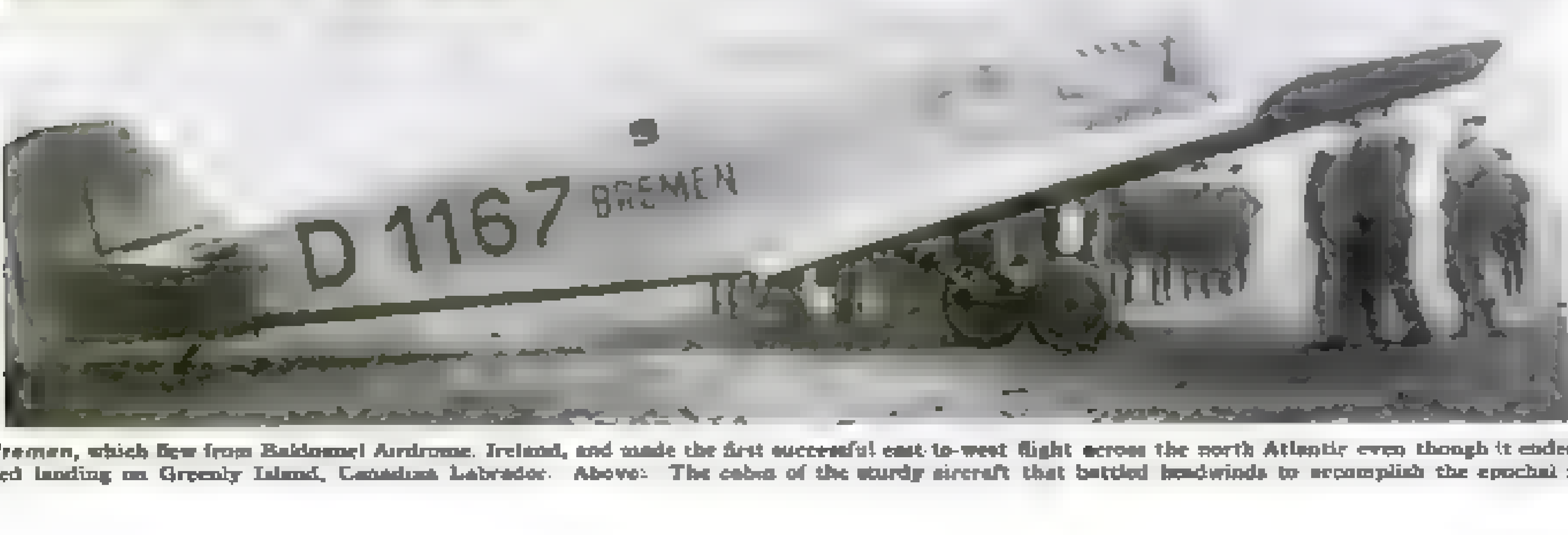
The chief factor which made possible this great conquest was the same which carried Lindbergh, Chamberlin, and Byrd safely on their eastward journeys to Europe—careful, scientific planning.

For months Captain Koehl and his financial backer Baron von Huenefeld prepared for the attempt. They knew that the odds were heavily against them, that they would fly into the teeth of death. Once, last year, Captain Koehl had hopped off in the *Bremen* for the westward journey only to be driven back by storm. Now he considered every possible chance of failure, and prepared to meet it with every device known to science.

At last, near the end of March, the *Bremen* was ready. [illegible] they hopped off from the Tempelhofer Airdrome, near Berlin, and flew to the Baldonnel [illegible] near Dublin, Ireland, where the start was to be made. There they were [illegible] of the [illegible]

[illegible] the [illegible] attempt





The *Bremen*, which flew from Baldonnel Airdrome, Ireland, and made the first successful east-to-west flight across the north Atlantic even though it ended in a forced landing on Greenly Island, Canadian Labrador. Above: The cabin of the sturdy aircraft that battled headwinds to accomplish the epochal feat

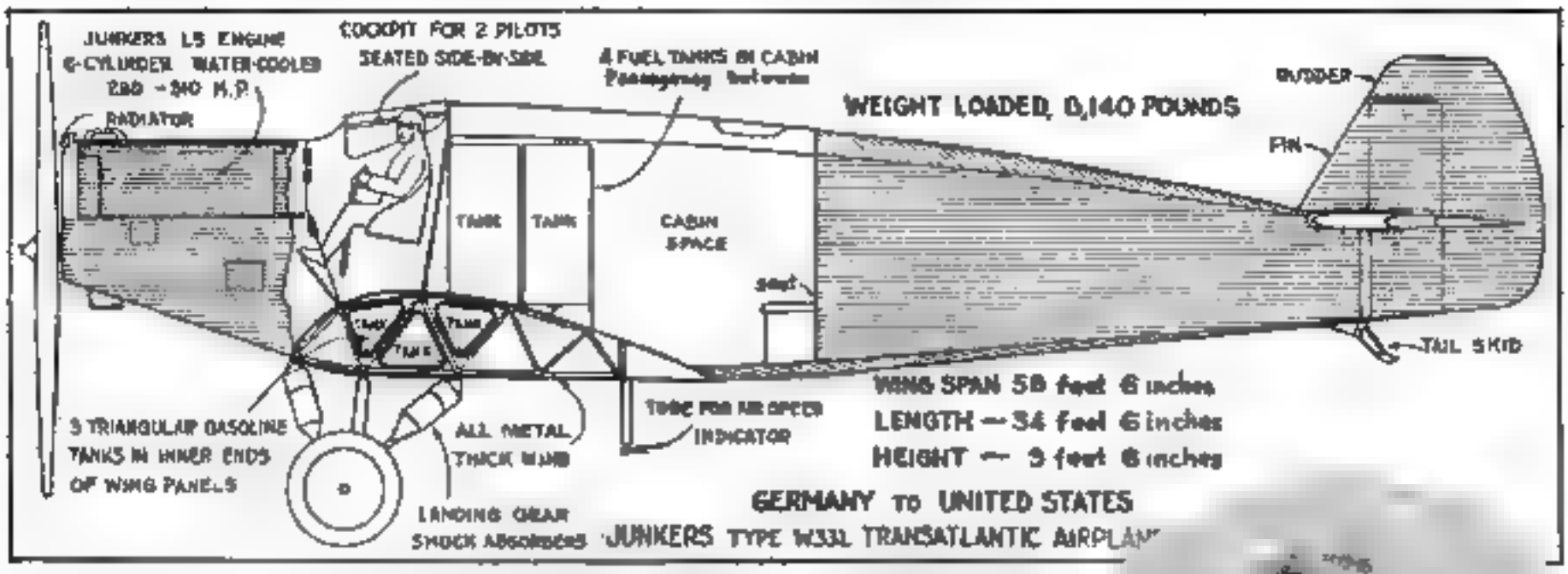


Diagram showing the construction of the ocean-conquering Junkers *Courtesy Aero Digest*

the difficult, hitherto unachieved westward crossing. It is a sister ship of the Junkers plane *Europa*, in which a few months ago the German pilots Johann Risztics and Cornelius Edzard broke the world's endurance flight record, and is like it in every detail.

THE two pilots sat side by side in the glass-enclosed pilot's cockpit. Dual controls enabled them to take turns without a perilous moment of uncontrolled flight. Before them roared the solitary Junkers six-cylinder motor, a duplicate of the one that hummed for fifty-two hours in the *Europa*, to the tune of 310 horsepower. An overhanging radiator cooled it with water, unlike the air-fanned motors of American trans-Atlantic planes.

Behind the pilots, and separated from them by a fire wall, were the great tanks that carried their precious gasoline—660 gallons of it. Back there, too, was the "cabin and freight compartment," now serving as a map compartment and a

Baron Ehrenfried von Huenefeld, passenger and financial backer of the *Bremen*'s historic flight

bunk for the third adventurer, for the *Bremen* is a standard Junkers plane, and others of its type are used for freight and passenger service.

Many of the modern ships that cruise the air would dwarf the *Bremen* by comparison. Its sturdy monoplane wings measure but fifty-eight feet from tip to tip. A man standing alongside it, on the ground, could all but touch the top of the cabin with his fingertips. From propeller to tail, a tape line would barely read thirty-five feet. That was the machine that sped over the Atlantic at a normal cruising speed of nearly a hundred miles an hour—which could be increased to 115 miles on occasion, not reckoning, of course, upon adverse

Captain Hermann Koehl, famous veteran German aviator co-pilot on *Bremen*'s gallant exploit

headwinds that would slow it down considerably.

Low-set wings combine with the corrugated metal sheathing of the fuselage to give the *Bremen* a distinctive appearance. Seen from the side, it looks humpbacked—a cabin beneath which, it would seem, wings have been added as an afterthought. Unusual, too, is the landing gear, so much so that it seriously worried witnesses to the take-off in Ireland, and caused them to stand by with axes and fire extinguishers to rescue the fliers from fire in case the gear should crumple under the plane's loaded weight of more than two tons and the gasoline tanks should break.

To keep the airmen on their course, a new pneumatic "telecompass," a sort of mechanical pilot, was designed for the *Bremen*. With this to guide them, and the knowledge that their gasoline supply

Colonel James Fitzmaurice Irish Free State Air Force chief, and co-pilot of the *Bremen*

would dwindle less than twenty gallons for every hour they were in the air, the airmen were prepared for their supreme attempt to reach the shores of America.

Weather conditions are almost always dead against an east-to-west flight. Fliers from Europe to America usually face hazardous odds estimated at eighty per cent greater than are encountered in the west-to-east flight.

Headwinds and freezing fogs—clouds laden with sleet and ice that form a heavy coat on the wings: these are the great menaces that the flyers from Europe must always meet. These two hazards have brought disaster to every airman who made the attempt before the *Bremen* succeeded. The prevailing winds are almost always—nine days out of ten—blowing from west to east—straight in the face of the European flyers. The greatest danger of all is in the freezing fogs and ice-laden clouds off the coasts of Nova Scotia, Newfoundland and Labrador. These ice laden clouds can so weight a plane as to force it from the air in 15 minutes.

THE coasts of Newfoundland and Labrador have been the graveyard, perhaps, of all the flyers who preceded the *Bremen*'s brave crew. The Weather Bureau forsaw overcast skies with rain around Nova Scotia, and winds of gale velocity off the Grand Banks, as a reception committee for the German plane. These adverse conditions the *Bremen* met and conquered—but they were lucky to escape the ice clouds. The fog and the clouds held only rain when they met them!

HOUDINI of the Desert

Face to Face with Savage Elephants; A Thrilling Story of African Wilds

THIS story is based on actual adventures which are recorded in the diary of Martin Johnson, the noted African explorer.

"Hello! don't you know me?" Thompson shouted. "Don't you remember what I used to do for you?"

By Fred Graves

Illustrated by B. J. Rosenmeyer

TWO men wriggled their way along the ground, stirring up a thin fog of white dust as they dug with elbows and heels to push themselves toward a low ridge just ahead. A naked sun scorched their backs. Leafless branches of thorn tree and *dom* palm by which they paused gave no shade. Across the cloudless sky a vulture wheeled.

In British East Africa, above the Kaisoot Desert, a vulture means death—some creature has died or is about to die.

One of the crawling men was nearly twice the size of the other. He was above six feet and broad in comparison. His sweat-soaked shirt revealed heavy muscles underneath. Twenty years of African travel, and more than twice that number of hair-raising escapes from death, had settled his clear features into an angular evenness. This was Marvin Thompson, noted American explorer, who for two decades had made Africa his hobby.

"There they are now," he suddenly whispered, and nodded toward a growth of low thorn brush.

The hand of Vanderpool, Thompson's companion, trembled as he shaded his eyes from the glaring sun. "Twenty of 'em at least," he panted.

As if in response, a score of huge black forms slowly emerged from the brush ahead and moved ponderously toward the men. A herd of wild African elephants, probably the most sagacious and savage beasts in the whole animal world.

"Shall I shoot?"

But Marvin Thompson laid a restraining hand on the rifle Vanderpool was about to bring to bear upon the leading elephants.

"No," he said curtly in an undertone.

A score of huge black forms emerged from the brush. Thompson laid a restraining hand on Vanderpool's rifle

The massive tusker leading the herd stopped in his tracks. He swept wide his huge ivory trunk and [illegible] would be useful now as if he had caught some slight vibration that betokened danger. His gigantic ears, like sails, spread on each side of face and head.

[illegible] for this [illegible] Vanderpool.

Thompson nodded, peering intensely ahead with unwinking eyes, but without taking his eyes from the menacing bulk ahead.

VANDERPOOL was right when he said he'd come for this." The fat, rich, sporting little banker had traveled all the way out from New York just for this moment. He had spent two hundred dollars or so a day to Marvin Thompson arranging for the small army of porters, syces and camels now encamped five miles in their rear. He had steamed nearly six thousand miles to Cherbourg, Marseilles, Port Said, Mombasa, before embarking in British East Africa his lavish equipment for this hunt. Then he had uncomfortably reised up the little rickety railway to Nairobi where he had met Thompson. Now for a fortnight he had struggled across the burning Athi Plains, gone to dirty, stinking Kitui, thence down to the native manyetta at Mutha where the hot level country is spotted with ugly *Bab-Bab* trees and overrun with thorn brush—all for this moment when he could shoot a wild African elephant.

And now he was being told he couldn't shoot!

Thompson continued to stare at the elephant leader.

"Why can't I shoot?" whispered the rich man angrily.

Thompson did not turn. He held his heavy .470 elephant gun at "ready," safety catch open and sights set point-blank.

"Because if they charge we're goners."

Vanderpool looked longingly from his own rifle to the elephants, then at the broad back and thick shoulder of the great hunter whom he had paid to guide him to this vantage point. Vanderpool was not afraid of the elephants. This was because he did not realize, as Thompson knew, that if the herd charged there was no retreat, no tree to climb, no defense. He did not know it was inconceivable that all twenty elephants could be stopped even with two rifles. Each animal would have to be hit in his small brain to drop him. Vanderpool wasn't afraid, simply because he didn't know any better.

In little mincing steps the mammoth bull came on. Gradually the distance between him and the white men closed to a hundred feet, fifty feet, thirty. In anger his huge elephant ears spread tensely fanwise to catch the slightest sound. His waving trunk strained outward to gather a telltale scent. Fury showed in the curious rhythmic swaying of his prodigious body.

THOMPSON lay frozen. Vanderpool, now impressed by the enraged black giant towering almost over them, also lay silent and unmoving. Occasionally his fingers twitched at his gun trigger. But he made no motion to shoot.

The same vulture overhead circled lazily watching the scene—waiting.

Marvin Thompson's thoughts were on his friend Lindsay who had been killed the year before by this very herd. Lindsay had shot with odds against him, just as the odds were now against these two; failed to kill his elephant; had been trampled horribly before his gunbearers could rescue him. Then there was Thorpe, who had been picked up bodily in a tusker's trunk and thrown against a tree trunk twice before the furious elephant saw fit to kneel upon him and squeeze out the last bit of breath the dying man's crushed lungs contained.

All the world, even Vanderpool, knew Carl Akeley had been set upon from behind by an elephant; had swung himself between the big fellow's tusks and miraculously lived to tell the tale. Though the beast had thrust downward, Akeley's body luckily lay between the ivory prongs. Hard earth or rock saved him.

Now, at thirty feet, the big bull stopped stock still. The other elephants stamped angrily in his rear. Slowly Thompson raised his rifle. If he must shoot, he must. Vanderpool raised his gun, happily unaware of the terrible peril before him. Every fiber of him yearned to pull the trigger.

THEN, as if by an act of Providence, disorder broke out in the rear of the herd. Perhaps a youngster stepped on the heels of an old one; or a crowding female unwittingly nudged one of her irritable sisters. A loud snort broke the strained silence of a moment before. Instantly the big bull turned and trumpeted angrily. With a single long stride he reached the nearest elephant behind him and butted him heavily with his head. At this the whole herd began screeching and blowing, roaring and stamping, pushing this way and that.

Thompson sprang half-crouching to his feet. "Quick! We'll get out while we have a chance!"

Running low, he led the way back through the brush. Vanderpool, blowing hard and streaming sweat, followed him.

"'Absurd,' he panted when Thompson let him catch up. "Here we travel half across Africa to get an elephant and are afraid to shoot when the time comes.'

Thompson shrugged, grinning a relief Vanderpool did not understand. "If I'd known they were so close I wouldn't have gone up where we did. Heat made 'em irritable. That's the reason we got away so easily."

"Well, what are you going to do now?"

"Go back to camp." Thompson glanced at his wrist watch. "In a hurry, too. We left those black devils six hours ago."

"Six months, from the way I feel," put in Vanderpool, mopping his brow.

"I don't like the way they were whispering around among themselves this morning," continued Thompson. "Anyway we'll get out early tomorrow and run a line of beaters to break up the herd. Then you can get your tusker."

"Hope so," snapped Vanderpool. He felt keenly he had been cheated. "Five thousand dollars to look at an elephant! *Phew!* I can do that in New York for a five-cent subway ride to the Bronx Zoo."

Suddenly he looked up. Then he stopped dead in his tracks.

"Hang that bird!" he ejaculated petularly.

"Just a vulture," said Thompson.

Vanderpool raised his rifle. "I'm going to shoot him," he announced.

"I WOULDN'T. Just means that the natives have killed something in camp, or that something is dying out here—perhaps an animal half-gutted by a lion. Why waste a cartridge on him?"

Muttering, Vanderpool put up his weapon and plodded stolidly on after his companion.

Their way led across an ancient outcrop of lava. The raw cinder mass thrust up out of the dry desert like a crusted spot of diseased earth's surface. It was gray-black, baking-hot with the sun and gnarled with the original fire that had forced it through the desert floor. This mass was a good quarter of a mile in diameter. To go around meant a much longer walk back to camp. Without discussion the white men chose to cut through the rutted space.

Halfway across Vanderpool, leading, slipped. His booted foot caught in a cinder crack and twisted. He grunted with pain and sat down.

"Nice trick that," he observed, feeling of the ankle.

Thompson ran the sweat off his wet brow with a dusty finger before replying. "Bad?" he asked.

Vanderpool tried to rise, then hastily sat down again. "Ouch!" he grunted. "No, only a twist. An old weakness. Broke it years ago when a horse fell on me."

Thompson looked hopefully across the gray, uneven plain toward the camp still hidden in the depression in which it lay. It was too far to shout. Perhaps one of the boys would ride out and see them. Unlikely, though. The native is not an energetic soul when out of sight of his white master. Lucky if the devils had properly made camp by this time.

"Got to do something. Sorry," murmured Vanderpool.

IT WAS true. The heat was beginning to "get" the older man. Two swigs at the tepid water in his canteen only seemed to accentuate his thirst and his nervousness.

Overhead still circled the vulture, meaning death.

Thompson did the only thing he could do.

By short stages he half carried, half dragged the injured man back. The extra effort in the merciless sun cost him much strength. But within his powerful heart and deep lungs lay a reservoir of energy equal to that of two average human beings.

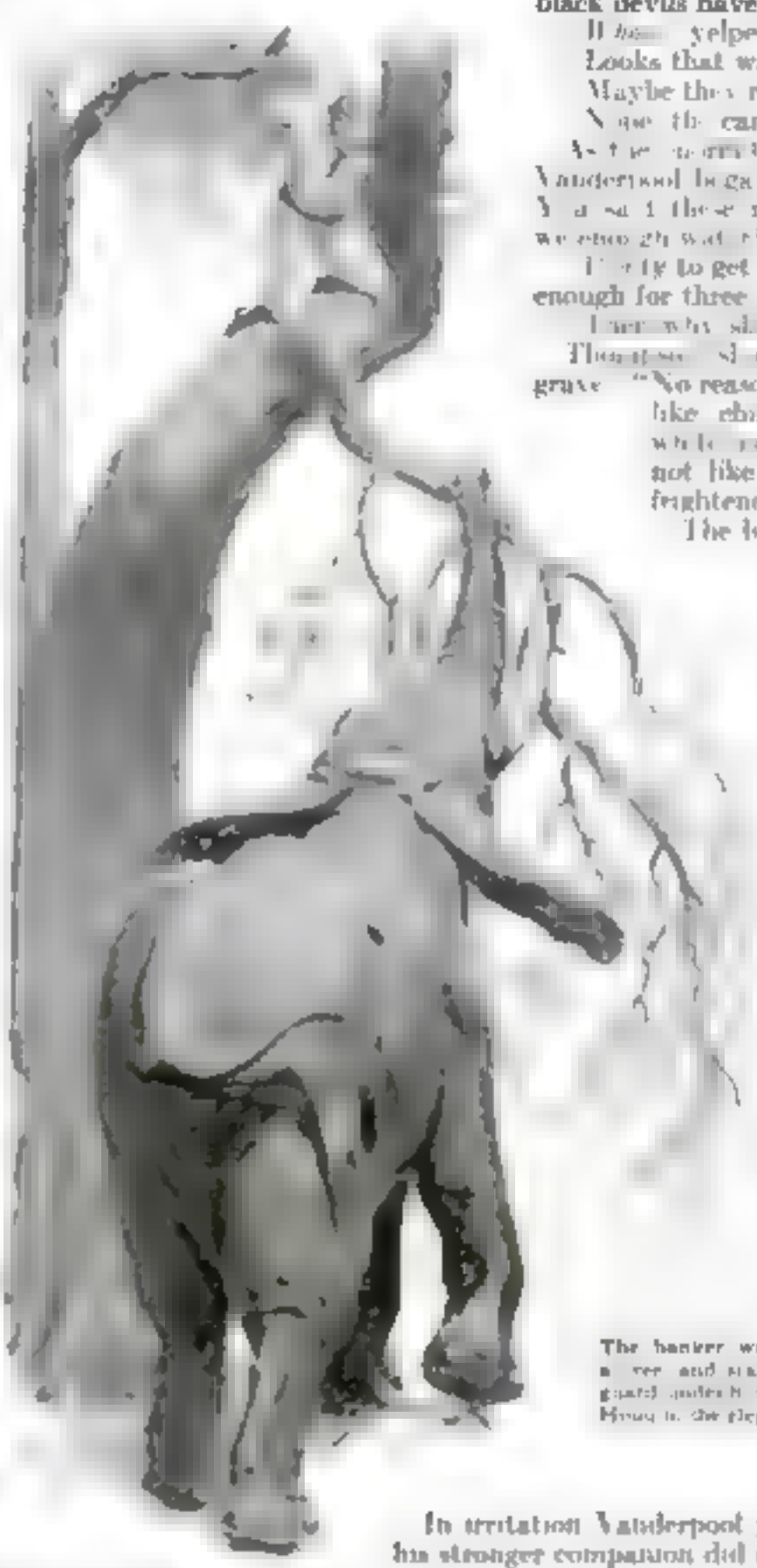
An hour passed before the slow-moving pair reached the edge of the depressed area in which lay the camp. Such a depression was chosen because it contained a clump of *doum* palms and because there might be a water seepage in the sand if the men dug deep enough. Thompson seemed to listen as he paused for rest.

"Mighty quiet," he observed. Then suddenly, as if struck by a thought, he added sharply: "You sit here."

He hurried on the last fifty yards that would bring the camp into sight. Abruptly he stopped, as if stunned by what he saw.

"Come on, let's get in," whined Vanderpool behind him.

Thompson almost ran back to his man. With slight ceremony he dragged Vanderpool to his feet.



The hunter was up a tree and standing guard while he was firing at the elephant

"They've gone!" he snapped out. "Those black devils have deserted us!"

"[illegible]" yelped Vanderpool.

"Looks that way. Not one in sight."

"Maybe they're after water."

"And the camels and donkeys are gone, too."

A terrible premonition of the offense came over him. Vanderpool began to sputter. "But it's mutiny! You said these men could be trusted. Haven't we enough water?"

"Plenty to get back to the last hole. And easily enough for three days' hunting here."

"Then why should they leave us?"

Thompson shook his head. He looked very grave. "No reason that I know of. This gang are like children. But they don't desert white men in the middle of a desert. It's not like them. Anyway, they'd be too frightened—"

The big hunter broke off with a queer gasp as he rounded the corner of the main tent that had been left standing. His grip on Vanderpool relaxed. His eyes focused upon a huddled figure propped against the single mangy thorn tree under which the tent was pitched.

WITH growing horror Vanderpool also gazed upon the apparition that confronted them. It was a native, dead, to judge by the complete immobility of his twisted limbs and contorted features. But even as they looked a low moan came from the parted lips of the wretch and a slight convulsion ran through his frame.

Despite his injury, Vanderpool started forward in an impulse to aid the stricken man. But Thompson seized him with a grip of iron.

"For God's sake, don't touch him!"

In irritation Vanderpool yanked his arm to free it. But his stronger companion did not loose his hold.

"You fool! Have you never heard of *Ghanda* fever?" cried Thompson.

"Never. Has this man got it?"

The other shrugged his irritation. "Most virulent disease known to man. At least so Gregg, the medico at Nairobi, tells me. See that fellow's chest?"

Vanderpool, who had not been able to take his eyes off the gruesome spectacle, nodded slightly.

"Those gray patches are the first stage. Rapidly they turn white. A sort of swift leprosy sets in. In a few hours the flesh disintegrates. Then death. *Ugh!*"

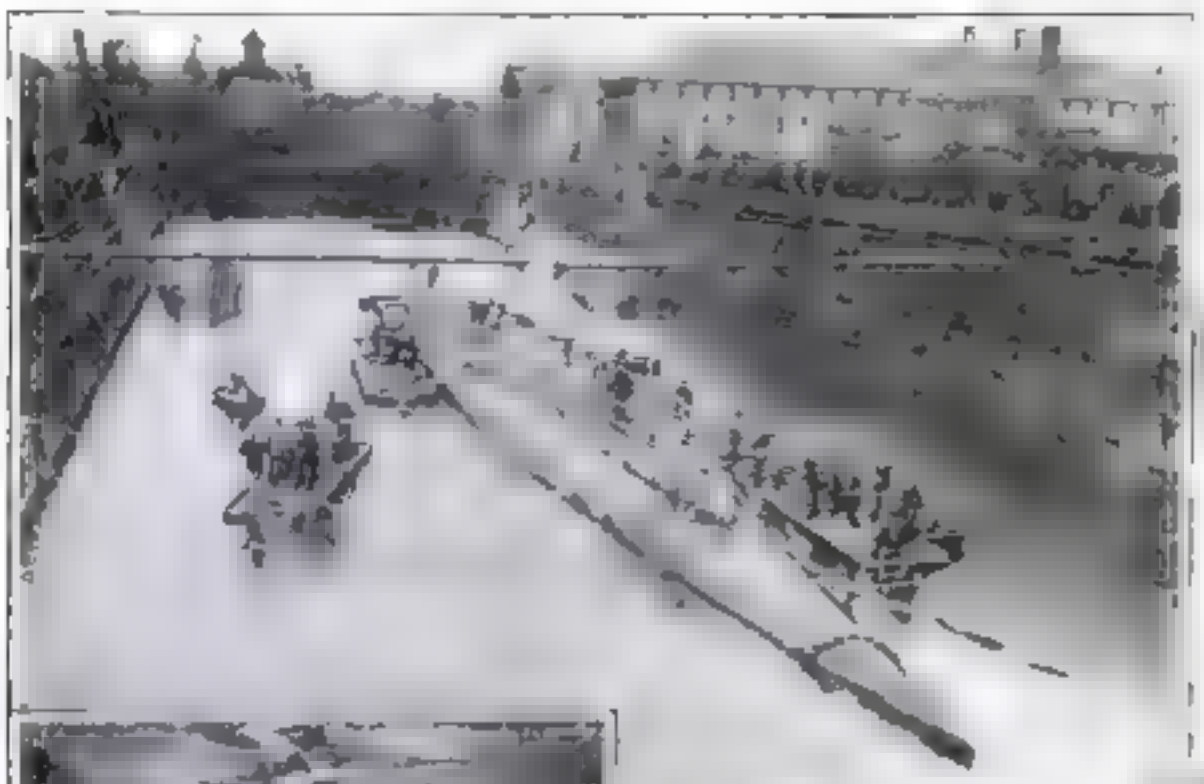
A sigh of despair escaped Vanderpool. Feeling the other's grip on him cease, he sat down weakly. "What are we going to do?" he asked.

BUT Thompson was already in action. First he ran to the top of a slight rise behind the tent and scanned the desert with his glasses. Once his gaze stayed some time on a quarter that was nearly due west. But the faint dust cloud he thought he saw, might or might not have been stirred up by a motley collection of madly fleeing savages, terror-stricken at sight of a traditional scourge.

Overhead still wheeled the vulture. But the bird of death was lower now and gliding gently with neck out-craned as if preparing to alight.

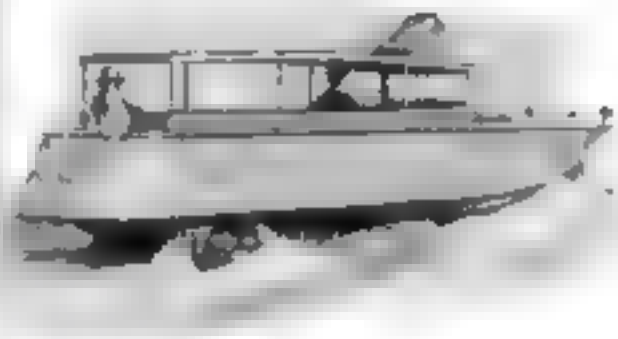
He returned to the tent, giving the dying native a wide berth. Quickly he gathered up a few items of (Continued on page 130)

Stories the Camera Tells



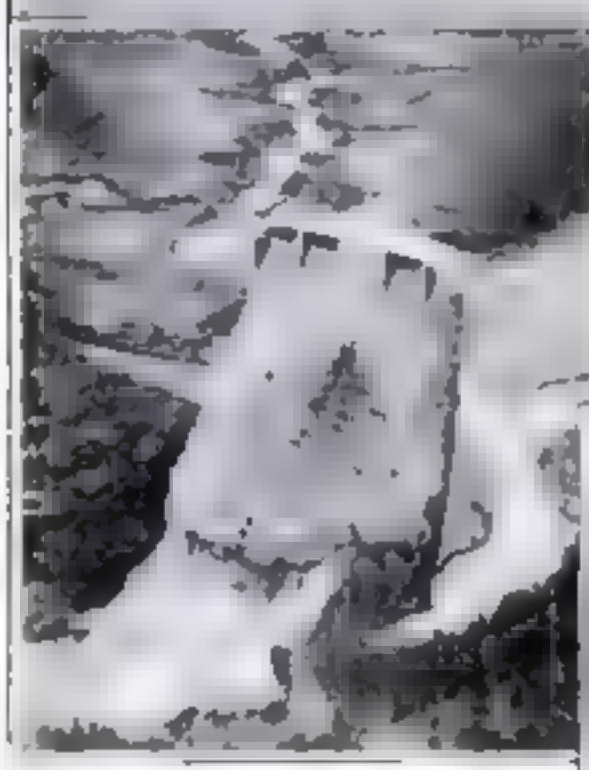
The Doomed S 4 Raised

The submarine that sank with 40 men emerges as water is pumped from the dry dock at Boston to which she was towed after gyrations often by her. The tragedy was described in the March issue of POPULAR SCIENCE MONTHLY



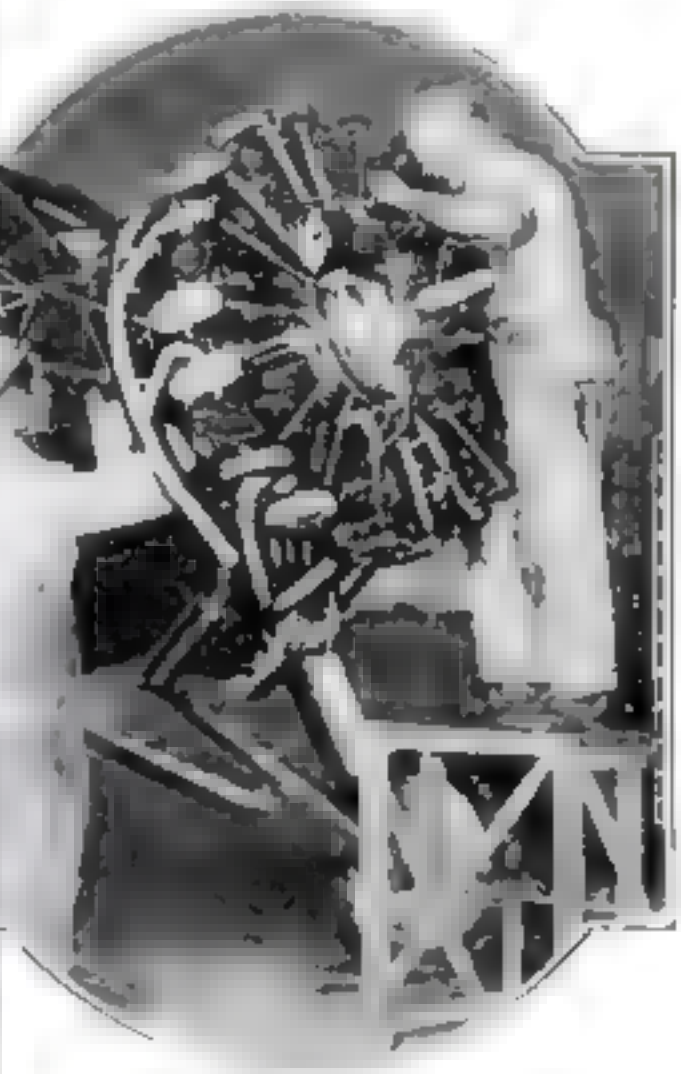
A Seagoing Auto

Dr. T. A. Jaggar of Hawaii will use this strange sea- and land car in exploring Pavlof Volcano in Alaska



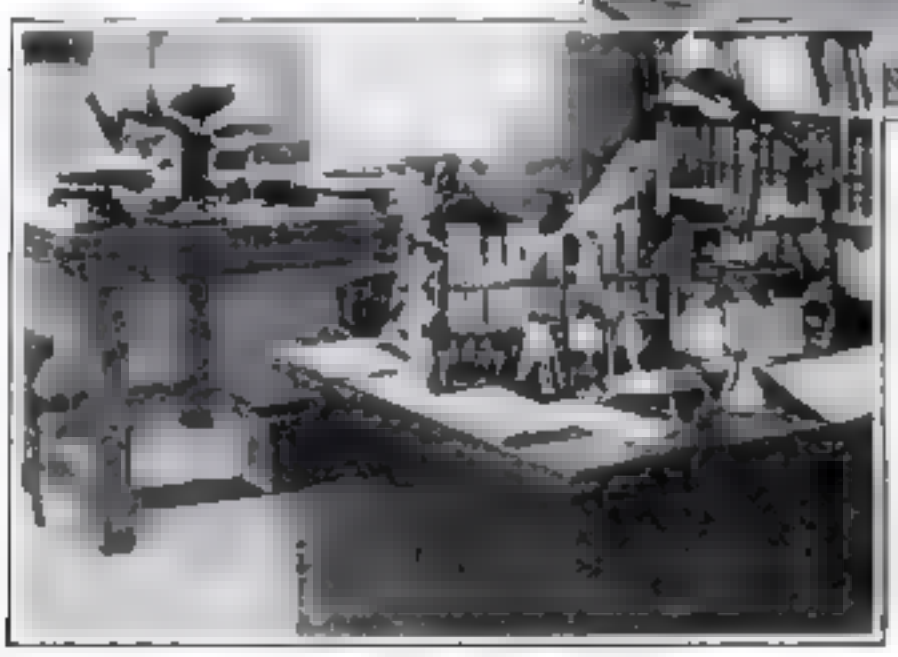
Breaking Dam's Heavy Toll

Four hundred persons are believed to have perished when the St. Francis Dam in California burst at both ends, leaving the middle standing, and from the canyon rushed a sea of water 100 feet deep on the inhabitants of the Santa Clara River valley. The torrent carried tremendous blocks of concrete from the broken dam. Above and at the right the wreck of the dam is shown



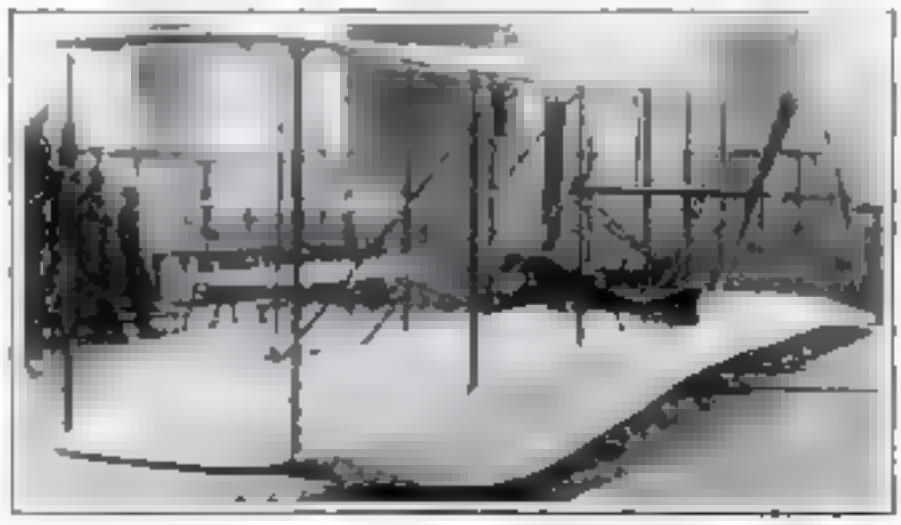
Lindbergh Designs a New Plane

Placing the engine in the Colonel's new cabin monoplane will make his famous *Spirit of St. Louis* that has fuel and oil tanks in the wings. Appointments suggested by "Slim" include headlights in wings, night landing flares, wheel brakes, and heater for the cabin



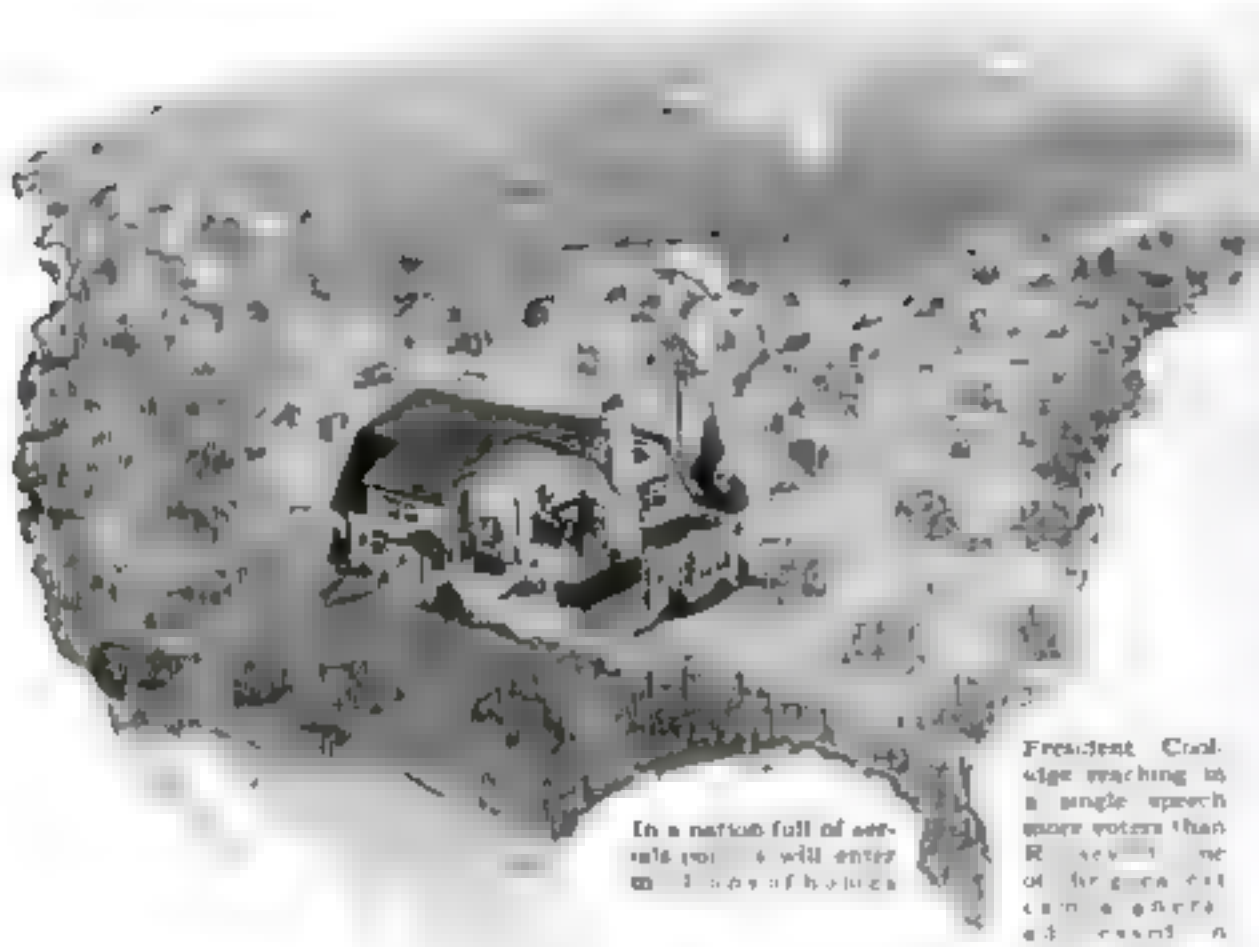
Edison on Job Testing Rubber

The "Wizard" examines specimens in his Florida laboratory in his tireless search for a new rubber, as told in the December issue of this magazine



Wright Airplane Shown in London

Here is the first machine that flew with man, at Kitty Hawk, N. C., in 1903, recently lent to the Science Museum, London, by Orville Wright



In a nation full of serials you will enter on [illegible]

President Coolidge reaching in a single speech more voters than R[illegible] of his guns can a[illegible] at events in his entire career

Radio Brings Politics Into Your Home

By Earl Reeves

THIS year radio will elect a President. There is eminent authority for that statement.

Calvin Coolidge believes radio is in large measure responsible for his popularity, and the White House view is that if radio can popularize a President it can elect one.

John W. Davis looks upon radio as one of the decisive factors four years ago.

General James G. Harbord—a radio authority who knows his political Washington—makes the flat declaration with which this article opens.

Beyond a doubt the most important political event of the last four years has been the development of radio and the "radio network."

In 1924 a really comprehensive radio campaign was impossible. Broadcasting stations were scattered and without central organization for program purposes. Receiving sets were fewer and such speeches as were broadcast frequently hit only the ear of an experimenter in his workshop, entirely missing most of the voters.

BUT now the radio set has been brought into the living room, accepted by the women; and the radio chain has been perfected. You can link up three big radio networks today and broadcast at once through sixty of the biggest stations. If you are important enough, or clever enough, your voice will be heard through receiving sets in five million homes. It is even possible, with interesting enough material and with the price—something between $20,000 and $25,000—to keep this colossal radio ear cocked in your direction for an hour at a time.

Four years ago the attempts at political broadcasting were limited to emergency arrangements for the small, lower-powered stations. This year, with machinery available to fill the air and with 20,000 or more candidates seeking the 7,000 local, state and national offices to be filled, it is going to be difficult to dodge politics. Let's have a look at this new machinery.

IN ONE chain are stations in New York City, Boston, Hartford, Providence, Worcester, Portland, Philadelphia, Washington, Schenectady, Buffalo, Pittsburgh, Cleveland, Detroit, Cincinnati, and Chicago. In a second hookup are stations in Boston, Springfield, Mass., Baltimore, Rochester, Pittsburgh, Detroit, Cincinnati, and Chicago. To either of these chains new links can be added, stations in nineteen more cities, Charlotte, Atlanta, Memphis, Nashville, Louisville, St. Louis, Minneapolis, Milwaukee, Davenport, Des Moines, Omaha, Kansas City, Oklahoma City, Ft. Worth, San Francisco, Los Angeles, Portland, Seattle, Spokane.

A third group has stations in Boston, Providence, Syracuse, Buffalo, Philadelphia, Pittsburgh, Akron, Columbus, Cincinnati, Detroit, Chicago, St. Louis, Fort Wayne, Council Bluffs, Kansas City, and Baltimore.

Behind these chains what political audiences wait?

Stunt broadcasts, in which the chains were used simultaneously, have resulted in claims that 7,000,000 radio sets and 35,000,000 listeners were reached. But the big commercial stations prefer to use a base figure of 6,000,000 sets; and to take into account the fact that, although theoretically all sets are in range and the whole nation "covered" by the networks, actually this is not quite true, and certainly not in all weathers. It seems fair to say, however, that there are within range of the sixty chained stations 5,000,000 sets, a *probable 10,000,000 voters*. By radio networks you have a chance of taking a political argument to them in their homes.

ROOSEVELT lives in our memories as our most strenuous campaigner. But, standing quietly in the White House, Coolidge probably has spoken directly to more persons than "T. R." ever addressed in all his active and joyous campaigning career. I do not know how many were numbered in the Roosevelt audiences, but the "stumping capacity" of James M. Cox, candidate for President in 1920, was figured at a million and a half listeners. At that rate he would have to campaign through a quarter of a century to meet from the rostrum and train platform the equivalent of a single Coolidge radio audience.

The "unchained" stations and their individual audiences are still with us, being some six hundred in number; but

Roosevelt as he appeared in his famous campaign. He couldn't reach as many people in a whole campaign as candidates now address in an evening

a great many—such as stations operated by colleges, commercial houses, and many even by newspapers—are not open to parties. Some, however, will be used during the campaign soon to open, but probably they are relatively less important. Some concentration of high-priced programs on the circuits has given the "channel" station the greater number of "constant listeners."

What, specifically, will this vast new publicity vehicle do in the impending campaign? The detail cannot yet be charted, but its outlines are visible, especially to such careful observers as M. H. Aylesworth, president of the National Broadcasting Company, which controls two of the three radio chains. His company plans, he tells me, to offer facilities to all the national committees, seeking to find in coöperation with them some equitable division of time. He expects to confine these national radio political meetings to a comparatively small number, believing that to be effective they must not be too frequent.

"WE SHALL recommend," he said, "that these meetings be designed as radio meetings only, probably broadcast from our studio, or possibly from the home of the candidate, without any visible audience."

Aylesworth may recommend as he likes, but a Speakers' Bureau headed by men well schooled in rally politics is likely to give us entertainments in which we hear not only the candidate but cheers, catcalls, and the blare of bands.

Edward Husing, head of another chain, points out that the band is likely to be used as the classic "frame" for a Presidential candidate. The band, he believes, will take its place on the air as successor to the torchlight procession, the drum corps, the Grand Army or the gray uniform, the bunting and the banners of earlier political eras.

Speech making, he contends, will have to be unemotional, tightly reasoned, simple and direct in wording. The use of the radio network he says will do away with campaign methods.

General Harbord points to his contention that radio will elect the next President as follows:

"Though Coolidge has been a President of few words, millions of people are familiar with his voice and have first-hand opinions of the policies for which he stands. No little share of his great popularity is due to radio. *This lesson will not be lost on the Presidential candidates in the next campaign.*"

The Radio Stump at Your Fireside Should—

1. **Increase the "silent vote."**
2. **Compel facts and reasoning instead of oratorical flag-waving.**
3. **Give people a wider understanding of concrete governmental problems.**
4. **Increase the women's vote.**
5. **Develop new campaign leaders who have the "radio appeal."**
6. **Break up party lines in some sections.**
7. **AND, by enabling speakers to talk directly to millions, make it possible for a man to be bigger than his party, as in the nation's early decades.**

Virtually all of Coolidge's speeches have been broadcast. He has reached more people with his voice than any other man in history. Several of his addresses have been relayed abroad and rebroadcast there. Letters pour in by the hundreds to each station in the hookup after each address.

"White House attaches are convinced that the President's appeal to voters the night before the last election brought out many thousands who otherwise would have stayed at home," says a statement that comes to me from the White House.

They further think that the most of these votes went to the man who did not blow his own horn."

If campaigners of 1928 believe that last statement, we may look for a new type of campaigning this year. The National Democratic Committee—that is to say, the organization holding over from the last campaign—offers this prediction:

Radio will be used quite extensively. Service will not be bought for every two-by-four campaigner, but the large central rallies will be broadcast, and on occasions when the candidate for President is to speak there will be extensive hookups. The service will be supplemented by the broadcasting of local rallies over local stations."

Each national committee will have in its Speakers' Bureau a man who is in fact if not in title *a radio campaign manager*. He will have to plot out the programs of big radio events and stretch the inadequate dollar to reach the largest possible "audiences." He will face a gigantic jigsaw puzzle also in planning use of single stations for purposes of gaining "accent" in doubtful districts. Somehow, he will have to turn on different types of argument in different districts, according to the sentiments of the auditors.

The most positive forecast I have obtained came from Joseph R. McCrea, in charge of the radio-speaker detail in the Republican Speakers' Bureau four years ago.

"In the Presidential campaign," he said, "I believe broadcasting must be on a chain basis. *All* the chains should be utilized, as well as smaller stations not in chains. No opportunity to use broadcasting should be passed up.

"As for hours, we should use all the time we have the money to buy, but not more than fifteen minutes at once, except perhaps for a few broadcasts by the candidates for President and Vice President.

"Radio has changed campaigning. It gives a better chance to the common sense type of individual who is not an orator."

It was Senator Dill, author of the radio bill, who directed my attention to the most intensive use of radio in a political fight in history, the recent mayoralty battle in San Francisco. Thousands who had never attended a political meeting were drawn in through the radio appeal. Talking directly to a family at home, unaffected by the ballyhoo of the mass meeting, *the candidate had to appeal on his merits or not at all.*

And as San Francisco was, so the nation will be this Presidential year.

Putting *the* Earth *on the* Scales

With Apparatus Only 3 Feet Tall, Physicist in an Underground Cave Measures the Pull of Gravity

By EDWIN KETCHUM

Through a telescope Dr. Heyl watches a beam of light reflected from a swinging pendulum. The movement of the pendulum, recorded by the light, shows the gravitational "pull" of near by objects on pendulum

IN A laboratory-cave, thirty-five feet underground, Dr. Paul R. Heyl, a physicist of the U. S. Bureau of Standards at Washington, D. C., is weighing the earth!

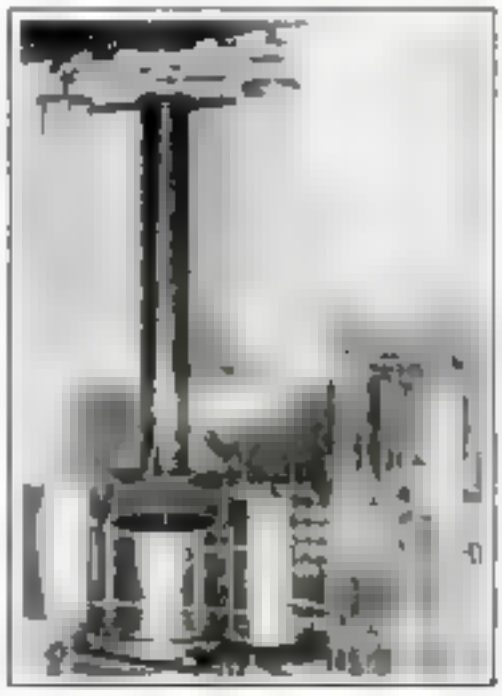
Twice in the last five years this modern Atlas has figuratively placed the mass of our globe on delicate scales. His last figures, announced about a year ago, gave its weight as 6,592,000,000,000,000,000,000 tons—a figure so enormous that it is beyond the grasp of most of us; so great, in fact, that if all the people were suddenly swept off the earth, the change in weight could not be detected. Now, with more sensitive apparatus, he is busy replacing some of the round numbers with more precise figures. The task will take several months, but in the end he expects to arrive at a measurement which will stand as the last word in accuracy for years.

That man, a mere speck standing on a globe 8,000 miles in diameter, should be able to weigh that globe, seems almost beyond belief. Yet, actually, the way in which Dr. Heyl does it is fairly simple and understandable. He merely applies the law of gravitation discovered by Isaac Newton more than two centuries ago.

THIS law, you recall, states that every particle of matter in the universe is attracted toward every other particle with a force varying directly as the product of their masses and inversely as the square of the distance between them. In other words, the force of gravitation acting between two bodies depends on two factors: their distance apart and their mass or weight. It must follow, then, that if we know the value of this force, the mass of one of the bodies, and the distance between the two, then we can calculate the mass of the other body.

This is exactly how Dr. Heyl calculates the mass of the earth. He asks the question: "How much mass must the earth have to exert the attraction it does upon a body at its surface, 4,000 miles distant from its center?" And he finds the answer to this question by first measuring the value of the force of attraction—a value which is known as the "constant of gravitation."

This force of gravitation is the most vital yet most mysterious, force in the universe. It holds the stars in place in the heavens, and it keeps the planets on their courses. Without it, we and our possessions would fly off helter-skelter through space.



The machine that measures the gravitational pull of cylinders on a pendulum, helping weigh the earth

It is the only known force which is absolutely unchanging, and which cannot be halted or obstructed. Electricity can be blocked by insulation, light can be excluded by any opaque substance but nothing has ever been found that will shut out gravitation. Newton, while defining the universal law of its operation, never found a way to measure it. Within the last century or so, scientists, improving precision instruments, have approached nearer and nearer to an accurate measurement, and figures have been revised accordingly.

Doctor Heyl tackles the problem first by placing, side by side, two small objects which can be handled readily, and measuring the gravitational attraction between them. Then he applies the result proportionately to larger bodies, such as the earth.

Most of us, if we think of gravitation at all when we weigh ourselves, think of it as a *downward* force. That is because we think of ourselves as *on top* of the earth. As a matter of fact, though, gravitation operates in all directions.

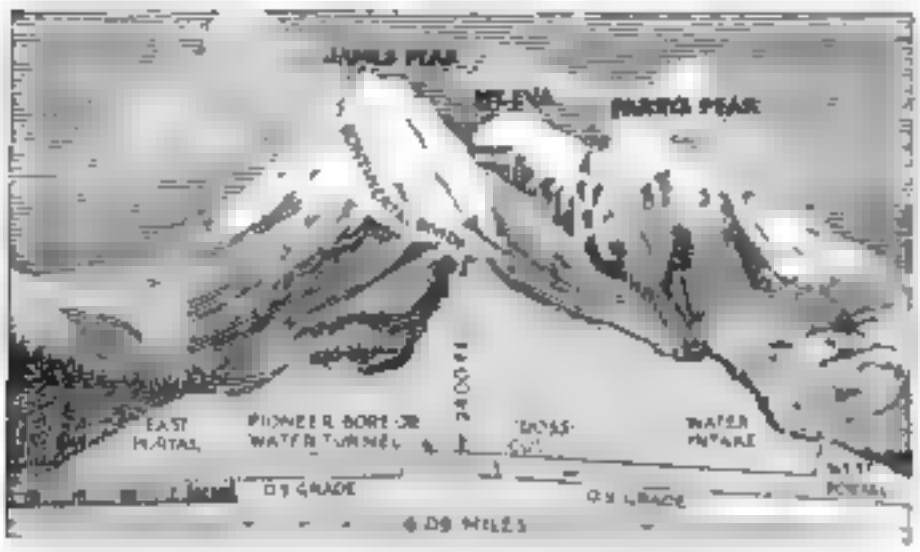
BETWEEN the pen and inkwell on your desk there is a constant horizontal "pull." All the objects in your room are tugging at one another. If the earth's gravitation were suddenly removed, the comb on your dresser might rush over to shake hands with the brush, and pictures on the walls might jump across the room to meet. Similarly, a rocket aimed at the moon, once it passed beyond the earth's sphere of gravitation, probably would fly clear off its course to some more massive heavenly body. The more massive the object, the greater its power of attraction. Your house and the one across the street pull at each other with a force of less than fifty pounds. When you step on the scales and find that you weigh, say, 150 pounds, you are simply measuring the earth's attraction for your body. If the earth were three times as massive as it is, you would weigh three times as much.

To obtain the greatest accuracy, Dr. Heyl does his "weighing" in a small room beneath the earth's surface. This not only assures the constant temperature necessary for the use of delicate instruments, but it prevents the upsetting of his calculations by the gravitational attraction of moving objects, such as automobiles and people.

If you should visit this underground laboratory, you would be surprised to find that his earth-weighing "scale" is an apparatus only about three feet tall. It consists of an instrument known as a "torsion balance," which measures the gravitational attraction between little glass balls weighing about two ounces each and steel cylinders weighing 140 pounds.

In a vacuum within an iron case hangs a light aluminum (*Continued on page 127*)

A Great Dream Opens an Empire



Diagrammatic drawing of the Moffat Tunnel, straight through the Continental Divide, cutting off 23 miles of circuitous railroad climbing up and down Corona Pass, and shortening transcontinental travel by 180 miles. The new and old routes are seen on the map at the right. The completed project provides easy access to a region rich in precious metals, oil, and timber whose value is in millions beyond estimation

THE Story of David Moffat, Last of America's Railroad Pioneers, Whose Daring Spirit Pierces the Rockies to an Area Large as France

By HOMER DYE, Jr.

A FEW weeks ago, officials and citizens of Colorado and Utah celebrated the passage of the first train through the new Moffat Tunnel in the Continental Divide. Through the six-mile bore, longest in the Western Hemisphere, a special train of forty cars sped in twelve minutes, completing a trip which previously required seven hours of tortuous climb over the Rocky Mountain barrier.

It was an event worthy of celebration.

It opened a new gateway between East and West.

It marked the culmination of one of the mightiest engineering feats of modern times, a colossal $18,000,000 labor, in which men and machinery pierced the solid granite of lofty James Peak.

It assured the opening of a vast inland empire, a walled in treasure land of coal, oil, timber, and precious metals, greater in area than all of France.

IT GAVE to Denver a long-sought place in the line of transcontinental rail traffic, and shortened travel across the continent by 180 miles.

But beyond all, it fulfilled the splendid dream of a Western pioneer and builder of indomitable spirit, who spent his fortune and gave the best of his life to make the dream come true. The man was David Halliday Moffat. The story of his struggles against overwhelming odds, of his superb triumphs and his tragic defeats, is one of the most stirring chapters in the history of American conquest.

It was back in 1860 that David Moffat, a lanky youth of twenty, arrived in the little town of Denver to seek his fortune. Born in Orange County, New York, he had started at the age of twelve as a messenger in a New York City bank and risen to be assistant teller at sixteen, and cashier of a bank in Omaha at seventeen. Then, moving to St. Joseph, Mo., he and a friend had conceived the strange idea of a stationery store in the frontier settlement that is now Denver. With six wagons and mule teams they had crossed the plains with their stock and provisions.

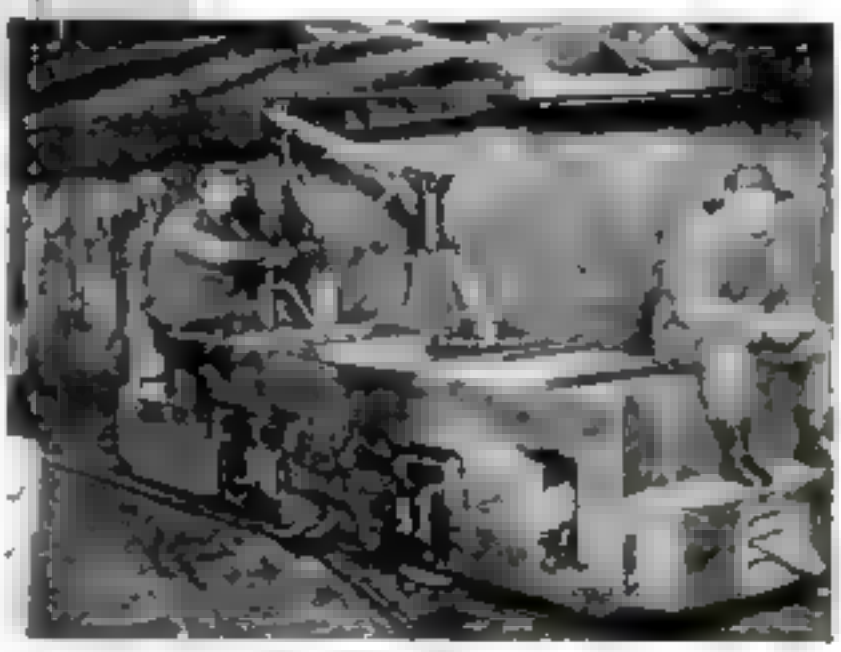
A portal of the Moffat Tunnel, $18,000,000 vision of the last great railroad builder, realized only after his death

The stationery store prospered. Moffat was a likable youth and his energy was untiring. In ten years he became president of Denver's First National Bank. In five more he was elected president of the Denver & Rio Grande Railroad. He had become a financial power. To build up his bank, Moffat undertook to build up Denver, reaching out on every hand with railroad lines into the mountains and over the plains. He fed merchandise and supplies to the new camps that sprang up. He acquired rich mining properties, and his trains bore him back gold and silver ore. He was the first in Denver to feel the thrill of great gold discoveries hundreds of miles away. He saw Gregory, Gulch, Boulder, Leadville, Aspen, Creede, and Cripple Creek—each a romance of the West—boom and die and boom again.

Because of his schemes of empire, friends and colleagues often called him a visionary. Time and again, when others ridiculed his proposals to extend new railway lines into new mining regions, he replied, "I'll build it myself."

AND he did. Those words became famous. Men learned not to laugh at Moffat's visions.

But one mighty obstacle to Denver's future remained a perpetual and baffling challenge to Moffat's pioneering spirit. It was the rocky wall of mountains stretching across Colorado from north to south—the Continental Divide, whose rampartlike peaks, wreathed in snow, towered to the sky. And locked behind that forbidding barrier, to the westward,



One of the powerful electric locomotives used by workmen constructing the tunnel. Electric power materially hastened the project

lay a great untouched land of natural treasure.

Other men accepted the barrier as insurmountable. Westward-moving wagon trains of the early days had veered northward through Wyoming or southward through New Mexico, for a way around. Railway builders later had followed the same trails. And there stood Denver, a hundred miles removed from transcontinental railway arteries to the north and south.

There was one partial remedy, and Moffat took it. With John Evans, the first Governor of Colorado Territory, he built a branch line connecting Denver with the Union Pacific at Cheyenne, Wyo., 100 miles to the north. But the wall of the Continental Divide still challenged.

It was a quarter of a century ago that Moffat, standing on a street in Denver and looking toward the setting sun, saw the vision which today has been realized. He was sixty-four years old. What of it? He had the faith and vigor of youth.

He summoned engineers and seizing a ruler, laid it across a map.

"GENTLEMEN," he exclaimed, "a straight line is the shortest distance between two points. I am going to build a railroad along the line of that ruler west from Denver to Salt Lake City! Some day I intend to build a tunnel under the Divide, but if for the present we can't go through, we'll go over!"

There were protests. A railroad line across that rugged mountain range? Impossible! Why, the lowest pass was more than 12,000 feet above sea level! Moffat dismissed the engineers and got others. These reported the grades and curves prohibitive, but they had found a pass—at what is now Corona—11,600 feet above sea level.

"That's 400 feet lower than the other fellows' figures," said Moffat. "We'll build the line.

The result was the Denver and Salt Lake Railroad—now the famous Moffat road—famous for its scenic beauty and as the line where tourists can get off the train in July and throw snowballs. It never reached the goal to the west, but it did scale the mountain wall. Winding up and around James Peak and through Corona pass, engines struggled with their burdens. Fighting the snow represented forty-one percent of the operating cost. And even then the line was impassable thirty to sixty days every year. The tremendous grades and curves made it impossible to draw long trains which could yield adequate revenue. The line itself was a losing venture, but it was the germ of a greater venture—the tunnel.

Governor Adams of Colorado (left) and former Governor Sheep on the way to drive a golden spike completing tunnel railroad

PERHAPS Moffat foresaw something of the disappointments and failures that would beset him, and that death would come before his dream could be realized. But not once did he falter. Into the project he poured his fortune of millions.

When he first went East to finance the Moffat road in 1902, men wondered why he should attempt to blaze such a difficult trail, but his project's financial basis was sound and powerful money interests promised to see him through.

He returned to Denver and began the unprecedented battle with the cliffs. Along a twenty-mile route, thirty-one tunnels had to be driven. To provide footing, workmen had to descend precipices on rope ladders and anchor logs to the sides of cliffs.

Special trains arriving at east portal of the Moffat Tunnel [illegible] Below, David H. Moffat, giant in way pioneer

But this was only half of the battle. The powerful Harriman interests were determined that the Union Pacific system in the north and the Denver & Rio Grande at the south were not going to suffer the competition of a rival line. Towns and cities which had sprung up along these routes [illegible] Unexpected obstacles rose mysteriously to block the advance of the Moffat project.

BUT Moffat went ahead. He built his line into Sulphur Springs. More money was needed to build down Gore Canyon. Again he went to New York for aid and was given promises, on the strength of which he gathered funds to build to Yampa. But when still more money was needed to go on to Steamboat Springs, he was told point-blank that "certain interests" had threatened to withdraw their deposits from "certain banks" if a penny was invested in the Moffat road. In all his life, this was the greatest sting of failure Moffat had ever felt, and it was delivered when he was approaching three score years and ten.

One day the big Westerner entered the old Hotel Belmont in New York and had a friendly head waiter conduct him to a secluded table where he might think out his problem alone. In the kindly face of the waiter Moffat recognized a fellow dreamer. They talked of their ambitions. That was the Westerner's way. Prospector, stage driver, mule "skinner," mine laborer, merchant, capitalist—all were the same to Moffat, so far as human values were concerned.

"You're right, sir," the waiter was saying. "But most of us must leave our dreams and go on with our work. Me, I dream of a ranch in the West—where I could be a producer—but most of us must compromise; I stay here with the work I have."

The Westerner rose.

"Don't compromise, my friend," he said. "For every dream, backed by willingness to pay

(Continued on page 131)

Seventeen-Year Locusts Coming

Insects Which Live Sixteen Years Underground And One Above to Visit Ten States This Season

By A. B. CHAMPLAIN

BROOD II of the "seventeen-year locust," or periodical cicada, is expected to make its debut this year. A coming-out party of these denizens of the underworld has been predicted for this summer by authorities, and we have been tipped off that cicada conventions will be held in portions of Connecticut, the District of Columbia, Indiana, Maryland, Michigan, New Jersey, New York, North Carolina, Pennsylvania, Virginia and West Virginia.

Something like thirty broods of the so-called seventeen-year locust are known in this country, and the cycles of their appearances have been tabulated in the territories occupied by each. Thus we may predict the appearance in any area of these Methuselahs of Bugdom. Brood I was with us last year, a trifle east of our expected Brood II. Brood III is midwestern, centering mainly in Iowa, and is expected in 1929. Brood X carried on in grand style in 1919 over the eastern and middle areas, extending southward to Georgia and Alabama, and will again appear in 1930. Brood XIV, an outstanding swarm, last seen in 1923, is due again in 1940.

The general region covered by the different broods together is east of central Kansas and north of northern Florida. No broods have been found in northern New England, except a doubtful record in Vermont, nor west of the Mississippi above Iowa.

A photograph of "a seventeen year locust" and a map of the territory it will visit this summer. Below: Eggs of the insect laid in a branch

OF COURSE, the "seventeen-year locust" is not a locust at all, but a cicada, one of the bug family. The true locust belongs to a different "breed of cats," and is a close relative of the grasshoppers, crickets, and roaches. To be scientifically correct, we should call the "seventeen-year locust"—the most famous and popular member of the cicada family—by its proper name, periodical cicada.

Most insects "grow up" in from less than one to three or four years. This renowned species remains in underground burrows sixteen years in the middle and northern states before emerging and transforming into the winged adult stage; while in the more southerly states maturity is reached in thirteen years.

Brood II occupies chiefly the more densely settled areas of the Atlantic seaboard. The experience of this territory in 1911 will tell us what to expect in 1928. Some of us, at least, will remember certain districts where the "locusts" swarmed at their best. As we approach some wooded region we hear the purring rattle of their ear drums, becoming almost deafening as we draw nearer. Closer, we hear individual sounds that vary from the "Pharaoh note"—which the general song is called—to the rasping squawk of alarm, when one of the males is disturbed. For, strange to relate, only the males can "sing." It was the ancient Rhodian poet, Xenarchus, who said,

"Happy the cicadas' lives,
"For all have voiceless wives."

Why only the males have the sound-producing organ, on the underside of their abdomens at the base, no one knows.

After we are accustomed to the chatter, other surprises are in store for us. Thousands of the creatures are on tree trunks, on foliage on the ground, jostling each other to find a comfortable perch; others are fluttering clumsily about. Let us look at one.

The periodical cicada is not "knee-high to a grasshopper," but from one and a quarter to one and a half inches in length. It is black, banded, and marked with some orange on the abdomen and has six reddish legs. Bright red spots like headlights artistically adorn the front, while four shiny transparent wings look well with their edges a network of orange-colored veins. Embalmed on each forewing is a dark brown marking. To the imaginative mind this represents the letter "W," and popular fallacies invest it with the prediction of war. But "seventeen-year locusts" have always worn this emblem, regardless of human history.

THEIR working tools are, first, the mouth parts, but they cannot bite; they have no jaws. A reddish-colored beak, located on the underside of the head, is used to pierce tender plant tissue and suck out the juices. It is not thought that any great damage is done plants in this respect. On the other end, however, the females are each equipped with a long, curved, horny egg-laying apparatus or ovipositor, with which they cut slits in tender twigs or stalks. Into these slits the eggs are placed in nice vertical rows. Naturally this severe treatment injures the twigs, many of which break. In orchards it often causes the loss of newly set fruit.

About the middle of June the eggs have all been laid, and the span of life for father and mother cicada draws to its conclusion. Soon the ground is strewn with their bodies.

But the vast progeny hatching and dropping from the tree tops delve into the soil with remarkable excavating machinery. Their forelegs are enormously developed for trench work, and as time goes on they attain a depth of twelve to eighteen inches.

Here they while away their childhood and youth, sipping sap from rootlets and growing larger as the years roll by. During this nymphal stage, cicadas are light brown or tan color, and this "coat of tan" is shed every two or three years to allow growth (Continued on page 140)

WHEN men now eligible to vote were four-year-old babies, some insects laid eggs and died. The story of those eggs is told here by Mr. Champlain, State Entomologist of Pennsylvania.

In hundreds of places, thousands of insects will come from the ground at nearly the same time. Why didn't they come last spring? Or wait until next spring? Flowers are brought out by the arrival of warm weather. But sixteen springs, all alike, have passed over these buried insects.

What is the mysterious, infallible alarm-clock Nature planted with those eggs seventeen years ago?

Science can't answer. It would like to know.

DICK BYRD—Adventurer

A Real Modern Romance, More Thrilling Than Fiction—In This Chapter: The Boy Who Dared

By FITZHUGH GREEN

IF YOU know the call of the open road, the lure of adventure, you won't want to miss a single installment of this absorbing biography. Here a lifelong friend and fellow Naval Officer reveals the real Commander Byrd. We follow him through perils and amazing conquests. We learn to know and love the slim arrow of a lad, in whose veins ran the spirit of voyagers of old, and who shot through barriers of the unknown to gain the heights of world renown.—The Editor.

ON A hot morning of July, 1903, Dick Byrd, age twelve, stood before his mother, his delicate narrow face showing pale through its boyish freckles.

"But I have to go, mother," he said in a low voice.

Mrs. Byrd glanced at the letter in her hand to hide the tears in her eyes. The letter was from a friend of the Byrd family, Judge Carlson, who had written asking if Dick could visit him in the Philippines.

"But you can't go alone," she objected.

Yet she knew the futility of her protest. For there before her stood the embodiment of five centuries of voyaging. In her son's veins ran the blood of the Norman, le Byrd, who in 1340 had landed at the same Ver sur Mer upon which his descendant was in 1927 to come roaring from the skies to the coast of France.

There before her was the reincarnation of old Colonel William Byrd, who had found England too small for him in 1671 and had burst the fetters of social convention by ferrying his family to the new continent Columbus had added to the mariner's chart.

Well might Mrs. Byrd weep in despair at the ruthlessness of birth as well as death. For in young Dick's thin lips, sharp eyes, and sharper mind were the conglomerate lips and eyes and minds of a score of enterprising Byrds to whom time and distance, men and money, were but trifling factors to be juggled to suit their vaulting fancy: Colonel William Byrd II, who had founded the city of Richmond; Francis Otway Byrd, who had won his fame at Tripoli; John Byrd, who in the heat of battle had given his life for his country in the War of 1812; patriots, seafarers, builders of empire, all of them.

"All right, my boy," suddenly said the mother, and, bravely smiling through her tears, clasped him to her breast as she must do again this summer when he sails away for the cruel Antarctic.

That same month the twelve-year-old adventurer set forth, to make the journey from Virginia to Manila unaccompanied. He had a new bag in which were neatly stowed a spare set of underwear, two Sunday ties, a jackknife, and a ball of string.

"I had a sort of feeling the train or ship might break down," laughed Byrd as he recalled this boyish whim.

The ship nearly did break down. He boarded her at San Francisco. On the twenty-third day out the sky became darkly overcast. A heavy ground swell caused her to roll deeply and yaw from side to side.

"Storm due," was the laconic notice posted by the captain in the saloon. "Passengers will keep to their staterooms."

It was young Dick Byrd's first meeting with the respect brave men have for a real storm at sea.

The typhoon arrived at midnight. Came a machine-gun rattle of rain across the deck, followed by a sharp gust of wind like that in the wake of a great gun's discharge. Then with full force the tempest broke.

At dawn the ship was leaping like a crazy thing. Howl of the gale forced men to roar to make their voices heard.

"Fore hatches tight?" boomed the captain to his watch officer on the bridge.

"Yes, sir."

"Deck gear lashed down?"

"Since yesterday, sir."

The old seafarer peered forward through an open port on the lee of the bridge, his eyes narrowed against the purple spray.

"THEN what's that?" he suddenly roared, and pointed to a blot of something huddled near the port chains above which green seas menacingly towered each time the ship rolled.

Two powerful seamen worked their way forward over the wet and rolling decks to investigate the "blot," which might have been a valuable hatch-cover or the like.

The blot turned out to be the huddled, wiry young body of the ship's twelve-year-old passenger from Richmond, Virginia, listed as R. E. Byrd, Jr.

"Wanted to see the storm," was the

excuse for his having disobeyed orders.

Upon hearing which, the old skipper swallowed an oath and directed the steward to "lock the young lunatic in his stateroom."

The skipper did not know a future "performer" was getting his first lesson.

ON THE second morning after Byrd's arrival in Manila, a native messenger burst into Judge Carlson's front hall. He thrust an official dispatch into a servant's hands and waited while the judge ran his eyes over the sheet.

"Big row down in the province below us," said Judge Carlson to his young visitor from the States. "Hum. Guess we'll go down."

The battle was over by the time the judge and his guest reached the scene. But while a guard of three American soldiers and a valuable Filipino prisoner were riding home through the thick tropical jungle, a native scout suddenly came dashing towards the party.

"Aguinaldo's men!" he shouted in his native tongue.

The ambush was serious, though the enemy's number was small. Without hesitating, Dick Byrd took the revolver one of the guard shoved at him and pointed it at the prisoner. Rifle shots *zinged* through the air, but he did not wince. The judge, an old soldier of distinction, took instant command. Presently a volley rang out from the Yankees. A scream followed, and a pattering of bare feet across the carpeted floor of the tropical forest. One prisoner with a flesh wound was taken and the cavalcade moved on through the jungle. Dick Byrd had seen his first action.

For his part in this brush with the enemy Dick was commissioned a deputy scout.

"I SPEAK for that lad now," said General Frederick Funston when he heard of the incident. "He has the makings of a man."

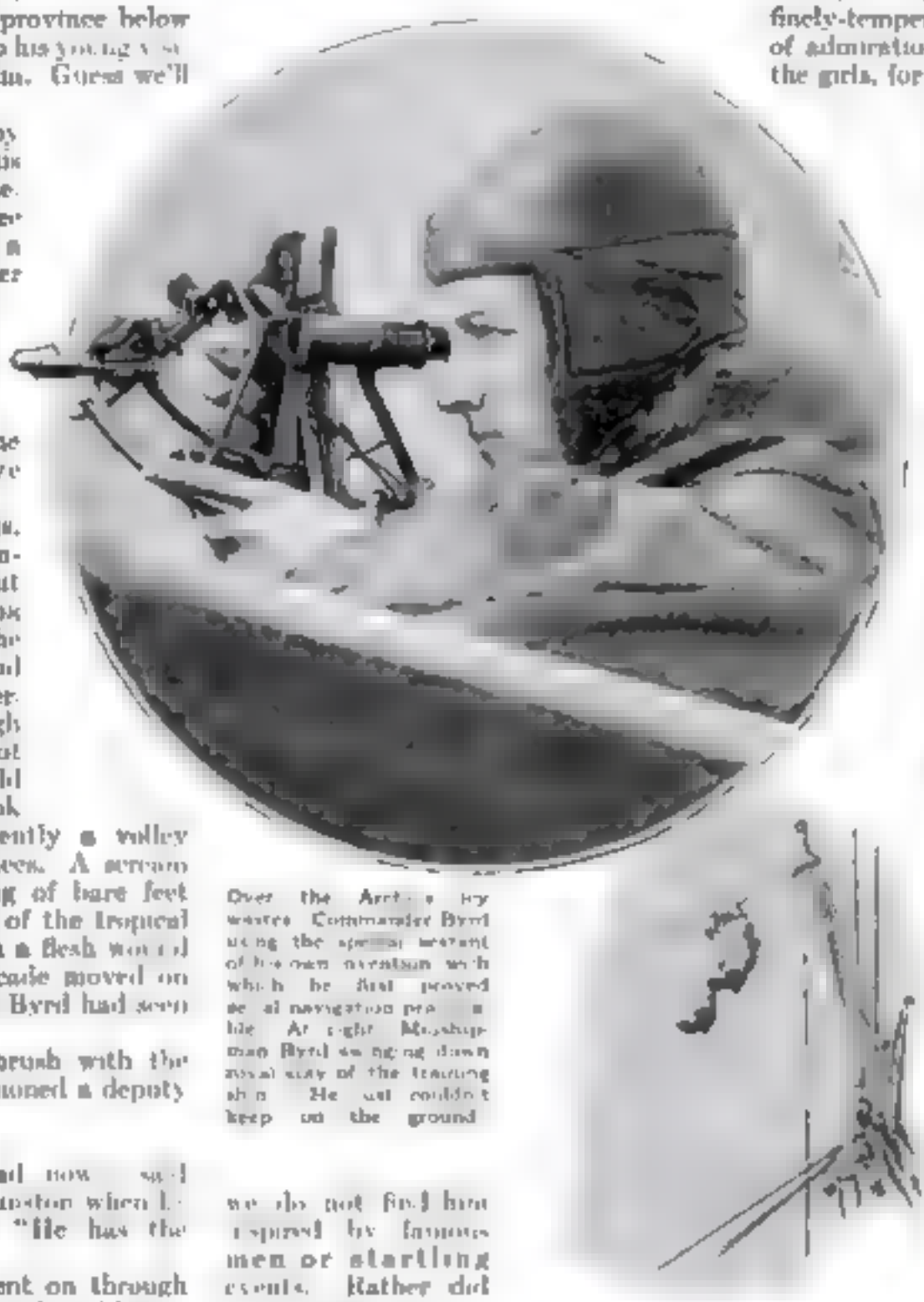
After Manila, Dick went on through the Indian Ocean, Suez Canal, and home, completely circumnavigating the globe. At the Battery in New York he was met by twenty reporters from big newspapers and news services. Twenty-four years later, in 1926, the same Dick Byrd returned from the North Pole and was met by some of the same reporters.

At about the time Dick returned from his world voyage the paths of the three Byrd boys began to diverge. Richard Evelyn Byrd, Sr., lawyer, orator and Democratic state committeeman, lived to see his own sons uphold their country's flag, but each in his own particular way. The father chose his eldest, Harry, to learn law, a profession that led the young man to governorship of Virginia by the largest majority in history.

Tom, the youngest, also would have followed in Harry's footsteps had not the World War intervened. Long months of hardship in the trenches taught this Byrd the joy of rich earth and sunshine. When he returned he could no longer endure an office life; so he fell to raising apples and is now a gentleman farmer of affluence.

Dick never recovered from his trip around the world. Wanderlust, first in his blood, then nourished by his boyhood voyage, carried him inevitably to the sea, thence to the air and to the ends of the earth.

Contrary to biographical tradition,



Over the Arctic by water: Commander Byrd using the special variant of his own navigation watch which he first proved as a navigation problem while At right: Midshipman Byrd swinging down vertical side of the training ship. He just couldn't keep on the ground

we do not find him inspired by famous men or startling events. Rather did he emerge from a gentle shadowy period of devouring tales of romance by the winter's fire and flying kites or exploring Virginia's natural caves by day, both, indeed, clear guideposts to the boy's future.

Now came the swift inevitable years of school, Virginia Military Institute, University of Virginia, and Annapolis—all culminating in the agony of two broken legs, one in football and one in the gymnasium.

BUT lesson by lesson Byrd was laying a foundation for the future. And it wasn't all in the classroom, either. For he learned the cunning art of bending another man to his will by use of fists, bared or padded, angered or cool, as circumstances demanded. Between wooden goalposts he learned the precious power of grouped physical effort; as crack quarterback of the Navy team he learned to direct that effort.

Probably his physical self found surest expression at Annapolis in his gymnasium work. The writer remembers him clearly, nearly twenty years ago, a slender agile youth, more the rapier than the staff.

WE RECALL one Saturday afternoon, day of a meet with Yale University. "Midshipman Byrd on the bars!" cries the announcer.

Out he comes, willowy and erect, finely-tempered human steel. A ripple of admiration runs down the galleries: the girls, for a middy famed as a superb dancer and fabulously handsome; the boys, for a middy who is humanly average in studies, amiable to his mates, and already marked as a football player and trackman of more than average ability.

Up he goes—swift, silent, poised.

"*Ah-h-h!*" from the audience, as he executes a sudden twist and swing that shoots his curving body out to a graceful landing on the mat.

Even then, in midair, he must have exhibited something of the birdman's deft subconscious *feel* of falling.

As we remember him, he couldn't keep on the ground. When gym days passed and the spring expanded, it was Dick Byrd who was always clambering during drill hours to the masthead to "spike his hat"; to the high roof of midshipman quarters to sun himself; to the brink of the River Severn's cliffs.

ONE final view we had of him the year he graduated—adjutant of the midshipman regiment, exalted to a place before a thousand other blue-clad rammods—reading orders in his fine, clear, ringing voice that was later to call across an icy desert to his desperate fellows.

At sea, an officer in the battleship fleet, he enlarged upon his knowledge when warfare ceased to be a game between teams, but was a clash between races. Slipping through tropical jungles and fording malarial rivers, he twice helped lead American bluejackets in putting down native rebellions, one in the Central American country of Nicaragua and one in the island of Haiti.

He began to know the meaning of emergency.

"It's the unexpected crisis," Peary once declared to me, "that takes the heart out of a man and numbs his judgment."

First-hand we know of two of Dick Byrd's lessons along this line, lessons that taught the young performer better balance and quicker recovery when

things went suddenly sour and black.

The first was in a battleship's turret which Byrd commanded for a gunnery season of two years.

One evening the man-of-war was in the region of the trade winds in the Atlantic Ocean just above the Caribbean Sea. A half-gale was blowing at the time, though the sky was clear. A West Indian hurricane had passed close aboard the night before and kicked up a heavy sea. Now the big ship was doing a good old-fashioned corkscrew

LATE that night Byrd was yanked awake by a quartermaster with a feverish message that the shells in his "handling room" were adrift.

This room was directly under the turret proper and contained many of the projectiles used for drill with the great guns directly overhead

Other ammunition was stowed away in rooms opening out from the central space. As Byrd ran forward, a big tool chest that had broken adrift lurched sidewise in the darkness and crashed against a bulkhead not six inches behind him

Outside the door to the handling room he paused. From within came the thunderous pounding of major caliber shells being thrown about. At that minute a hand fell heavily on his shoulder.

"Man in there, sir!" It was the gunner's mate. "Hurt. Can't get him out account them shells."

The entrance door was jammed. A massive loading slug had broken loose first and wrecked it.

Byrd dashed back up the ladder and ducked into his turret. Like a snake he worked his way down through the trunk that led below. Three men followed him.

THE handling room was dark when the rescuers peered into it from the turret hatch. Then by a hand light they could make out a dozen black bodies plunging to and fro with terrific momentum whenever the ship rolled. They looked like monstrous black rats darting about in hopes of escape. The injured man had crawled to a beam overhead. He could hold on only a little longer; then he must fall and be crushed by the steel projectiles.

There were plenty of suggestions about how to capture the shells and save the man so close to death. Lassoing, wedging, shoring and hoisting out with falls were all spoken of. But Byrd did the trick with neatness and dispatch. He passed word back to hand down all hammocks and mattresses close at hand. In ten minutes he had ingeniously and effectively *smothered* the projectiles from above!

As there was "live" ammunition just on the other side of a thin bulkhead, his action may have saved not only one life, but even the whole ship with her thousand-odd souls aboard.

Another little party that helped teach Byrd to think quickly happened off the Virginia Capes one raw, dark morning in early April. His ship, the U.S.S. *Dela-*

"Tom (left), Dick (right), and Harry," famous trio of Byrd brothers, at the beginning of their careers. Harry became governor of Virginia and Tom a gentleman farmer. At right: Dick hobbling on crutches after smashing a leg in gym

ware, was testing plane pontoons in a seaway. A spring nor'easter came striding down the coast and put an end to the tests. As the pontoon gear was being hoisted aboard, a seaman lost his balance and fell into the boiling seas alongside

Dick Byrd was standing near the rail when it happened. "Man overboard!" someone yelled. But Byrd, quick-witted, shouted the right words first

"*Hold that winch!*"

The officer-of-the-deck did the thing he was trained to do. He sang out "Away starboard lifeboat!" Correct but futile; for the man in the sea was drowning. Moreover, there was no lee for the whaleboat on either side of the man-of-war

After that first shout Byrd was quiet. He scarcely moved. Then, suddenly, like a trained acrobat he peeled off his coat and kicked off his shoes. On the armored counter he poised for a dive. As the quarter deck steadied at the top of a giant upward heave, he went over

His thin, wiry body curved out and down. Cleanly he slipped through the face of a big green wave, and was presently out the other side not ten feet from the drowning man.

"*He's got him!*" screamed an excited sailor from the upper deck.

Byrd had; and neatly he held the lucky devil until a lifeboat coxswain eventually hauled the dripping pair over his gunwale.

THREE times Byrd saved drowning men. And his country gave him the famous Congressional Life Saving Medal. But the medal and the achievement were unimportant compared to the practice the young officer had in judging a tough break promptly, acting on the spur of the moment, and coming out of the jam alive. Those were the things that were to make him a competent performer when his big day came.

In 1916 the doctors decided that despite his fine record, Byrd's bad leg (the one he had smashed in the Annapolis gym) was too fragile to permit him to continue on active duty. He was retired.

Retirement, or shift to inactive duty, meant that he was listed with the useless cripples. He was a Government pensioner on a stipend of about $100 a month; nothing to do and plenty of time in which to do it.

Then came the war. By medical judgment unfit for sea service, Byrd decided he must still serve his country. An aviator sits down, he reasoned. And he had long cherished a dream of flying across the Atlantic.

"No use," the doctors told him, "you are not fit for such work."

The verdict hurt deeply.

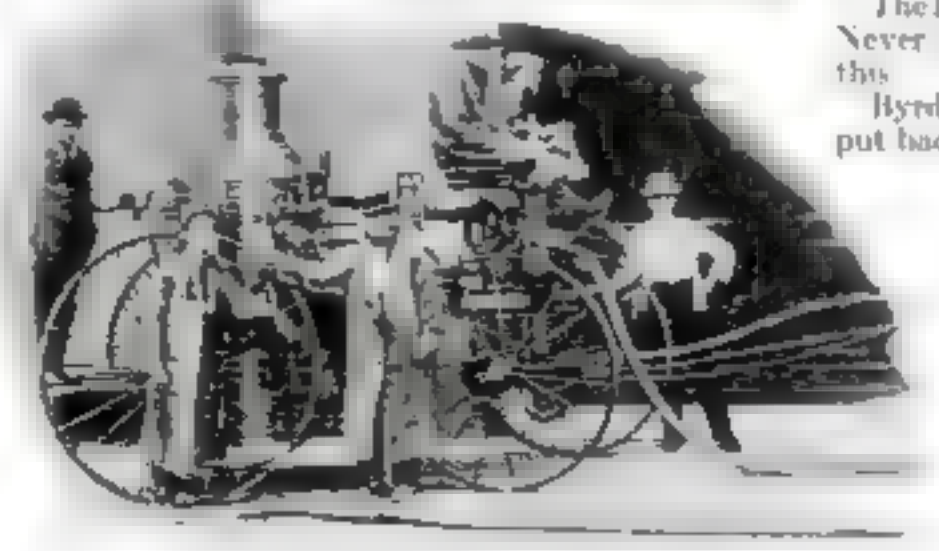
"GIVE me a chance," he begged them. "The trouble is only a bad ankle. Let me have a month of training and I'll show you what I can do."

The high ranking naval surgeon blinked. Never before had he been talked to like this

Byrd was passed conditionally. He was put back temporarily on active duty and ordered to the naval air station at Pensacola, Florida.

Now began a new phase of his training, exploratory as well as naval. As were the sledge and the covered wagon, the ship and the bark canoe, the vehicles of the early explorers, so today is the plane the one swift craft that carries the scientific pioneer across the frontiers of the unknown. Christopher Columbus without his ship could not have been more

(Continued on page 130)



Dick's early yearning for adventure made him an ardent follower of the volunteer fire brigade. As usual, he has climbed to the front seat (far side)

Ship Swallows Whole Trains

By
ELISWORTH
BENNETT

The seagoing ferryboat that carries 100 passengers and two entire steam trains is shown here with one of its jaws raised to receive a train

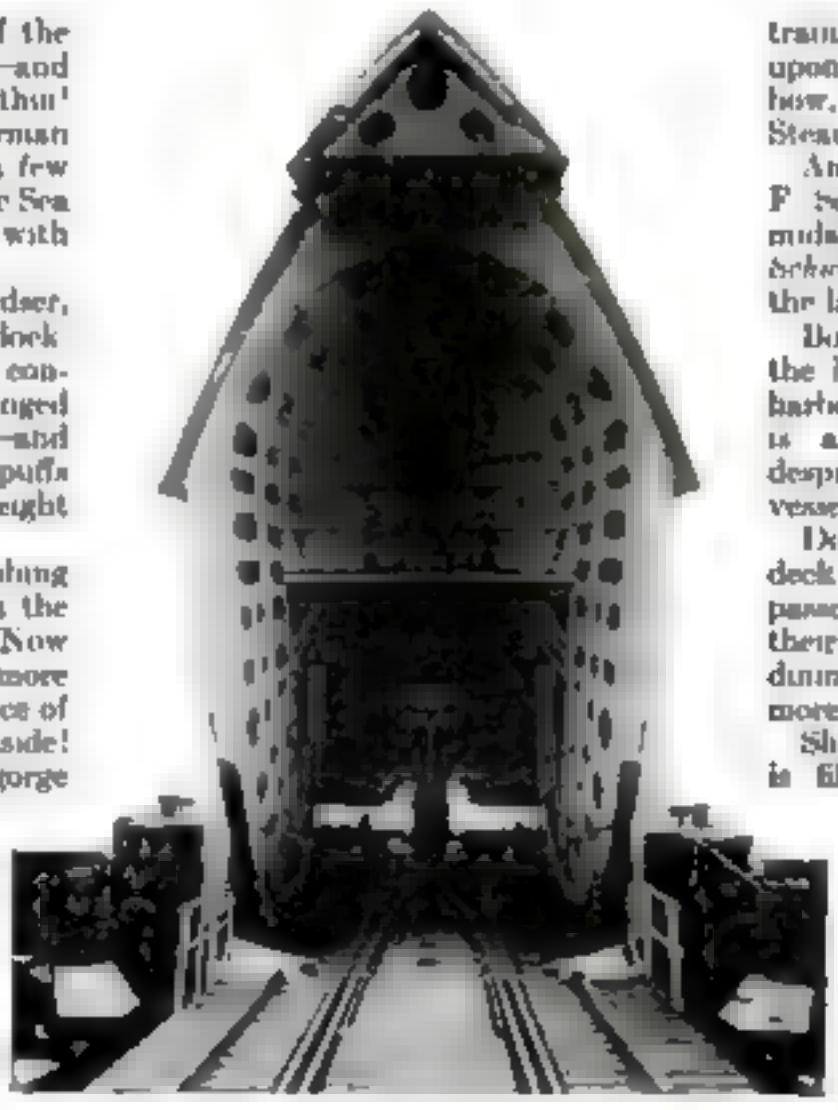
Mammoth Seagoing Ferryboat, Strangest Craft Afloat, Carries Two Whole Railroad Trains Gulped in by Its Cavernous Jaws

WIDE open swing the jaws of the newest monster of the deep—and a railroad train disappears within! Like a fairy tale dragon is the German deep-sea ferry *Scheerin*, launched a few weeks ago, that plies across the Baltic Sea between Denmark and Germany with whole freight trains in its hold.

People crowd the wharves at Gedser, Denmark, to see the strange vessel dock. Slowly, with the muffled chugging of concealed steam engines, the great hinged bow splits open—rises in the air—and yawns wide. Out of the black maw puffs a locomotive with a load of twenty freight cars.

While the spectators are still rubbing their eyes, another train rolls down the wharf and vanishes into the hull. Now the "jaw" descends, making once more an ordinary-looking ship with no trace of the engine and cars swallowed up inside! From either bow or stern it will disgorge its cargo upon its return to Warnemuende, Germany.

When the German Federal Railroads sought a single vessel to replace two paddle-wheel ferries then serving Berlin-Copenhagen traffic, their first demand was for a vessel that could take on cars from either end. Ice often clogged the harbor and made it impossible for ferries to turn around. In order to run trains straight through the boat they hit upon the bold idea of hinging the whole bow, a few feet above the waterline. Steam engines would swing it open.



Looking through the *Schwerin* with both bow and stern jaws, through which trains enter and leave, opened their widest

An enterprising German shipbuilder, F. Schichau, of Elbing, tackled the formidable order. When the 350-foot *Scheerin* was launched, it embodied all the latest ideas in ferry design.

Both bow and stern are fitted to break the ice at the narrow entrances to the harbors and both have rudders. Thus it is a true double-ended "ferryboat," despite its resemblance to a standard vessel of the sea.

Double railroad tracks on the main deck accommodate twenty European passenger cars, or forty freight cars with their locomotives. In addition there are dining rooms and sleeping cabins for more than a hundred passengers.

Should the ship list when but one track is filled with cars, water is pumped from "careening" and "trimming" tanks on one side of the hold into those on the other, until the vessel's loaded weight of 3,000 tons is evenly balanced.

The *Schwerin*'s speed is eighteen miles an hour. Its 4,400-horsepower battery of two steam engines gets power from oil-fired boilers, as do three dynamos to supply electric light, heat, and ventilation.

"The Monster of the Baltic" crossing the sea under 4,400 horsepower of steam with a couple of railroad trains besides a hundred people as cargo

The main deck interior showing the single track becoming double. Trains can enter at either end and could pass each other on the boat if desired

HUGE Flying Hotels Race For First Overseas Flight

By CARL HELM

FLASHING silver against the sun, the giant dirigible heads out to sea. A hundred people on her passenger list, and every cabin full!

On the streets below crowds strain their eyes and wave their farewells as the drone of the motors of the flying hotel recedes.

The "Queen of the Air" melts into a cloud. She is gone! Day after tomorrow soon after dawn, she will arrive in London. Thirty-eight hours from New York to Europe—the fare is $400.

That is no dream of the far distant future, for within a few months the trans-ocean passenger-carrying dirigible should be undergoing its great test. Two nations, England and Germany, are racing for the glory of sending the first air liner, with fourscore or more passengers, across the Atlantic to New York

That feat accomplished, the dream of a cruise by air to Europe and back approaches actuality.

AERONAUTICAL authorities agree that when the dream comes true, it first will be through the development of the rigid airship. The airplane's capacity as a passenger carrier is necessarily limited by its type of construction, its fuel requirements, and the vagaries of weather. As a means of transportation it is to the dirigible as the speedboat is to the ocean liner; or, in the equation of comfortable travel, as a motorcycle to the Twentieth Century Limited.

At this writing it seems likely that the British air liner, *R-100*, the biggest airship ever constructed, will be the first to cross the Atlantic. The U. S. Post Office Department is already looking to the use of her facilities. Comparison with her aquatic rivals is in order

She is 709 feet long, forty-nine feet longer than the *Los Angeles* and a scant fifty feet less than the S. S. *Mauretania*. She is 133 feet in diameter, greater by thirty-three feet than the width of the *Leviathan* or the *Majestic*, the world's largest steamships. In weight fully loaded, she is 101 tons. On her nose she would come within eighty-three feet of the top of the sixty-story Woolworth Building. She weighs six tons more than an express locomotive

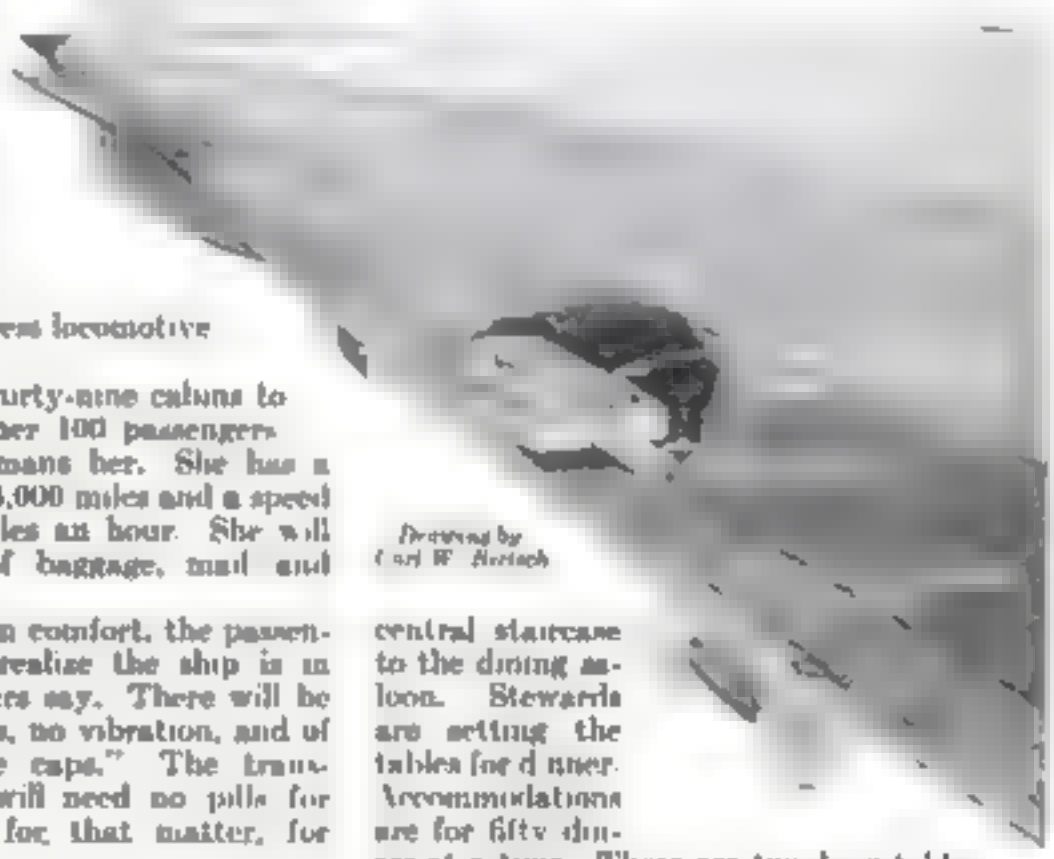
THE ship has thirty-nine cabins to accommodate her 100 passengers. A crew of forty mans her. She has a cruising radius of 4,000 miles and a speed of eighty-three miles an hour. She will carry ten tons of baggage, mail and freight

As for crossing in comfort, the passenger scarcely will realize the ship is in motion, her builders say. There will be no noise of engines, no vibration, and of course no "white caps." The trans-Atlantic voyager will need no pills for mal-de-mer, nor, for that matter, for mal-d'air!

Suppose you are on your first trip. You and your luggage have come up an elevator inside the towerlike mooring mast just outside New York. You enter from the mast through a door in the bow, and walk along a wide companionway in the hull of the ship to the passengers' saloon, about a third of the way back in the structure. You are inside the great ship, but the interior is flooded with sunlight through huge plate glass windows.

A steward guides you to your cabin. As to size and equipment, it is exactly like a first-class steamship cabin for which you would pay $250 on a good trans-Atlantic liner. Steamer trunks are stowed under the berths. The lavatory has hot and cold running water. Heat is furnished by electricity. A porthole looks out through the "view windows" to the ocean.

The bath, with showers, is just outside the cabin. You walk through the lounge. Passengers sit in club chairs, chatting, or at refreshment tables. You go down the

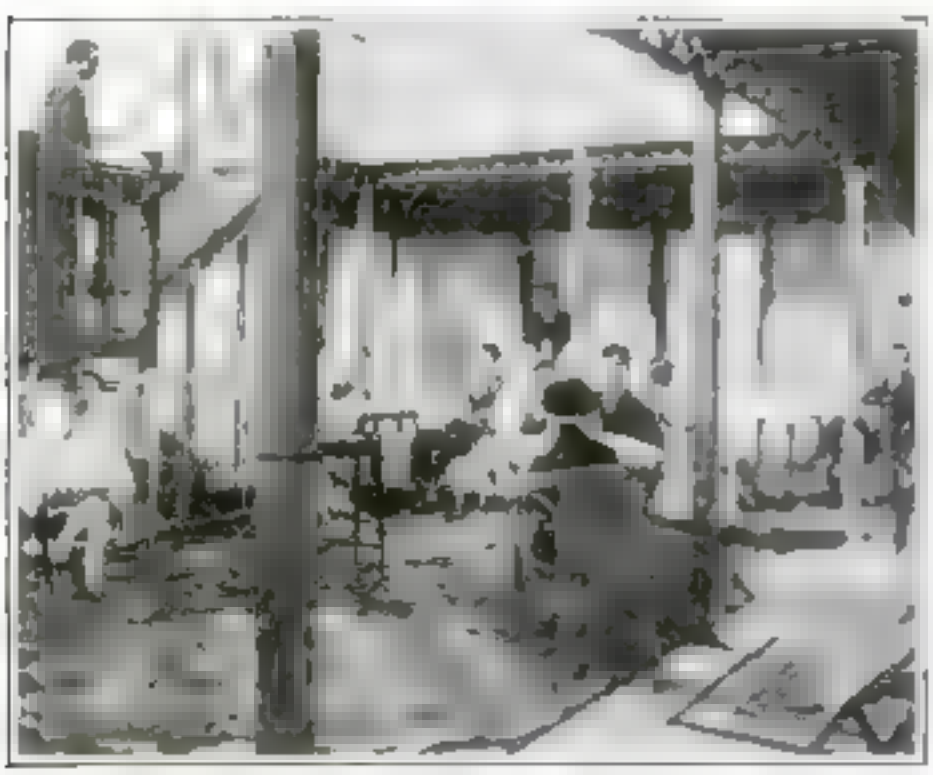


Drawing by Carl W. Hertsch

central staircase to the dining saloon. Stewards are setting the tables for dinner. Accommodations are for fifty diners at a time. There are two long tables seating eight persons each, six that seat four each, and five that seat two. The electric range, with the busy chefs, is in one end of the saloon.

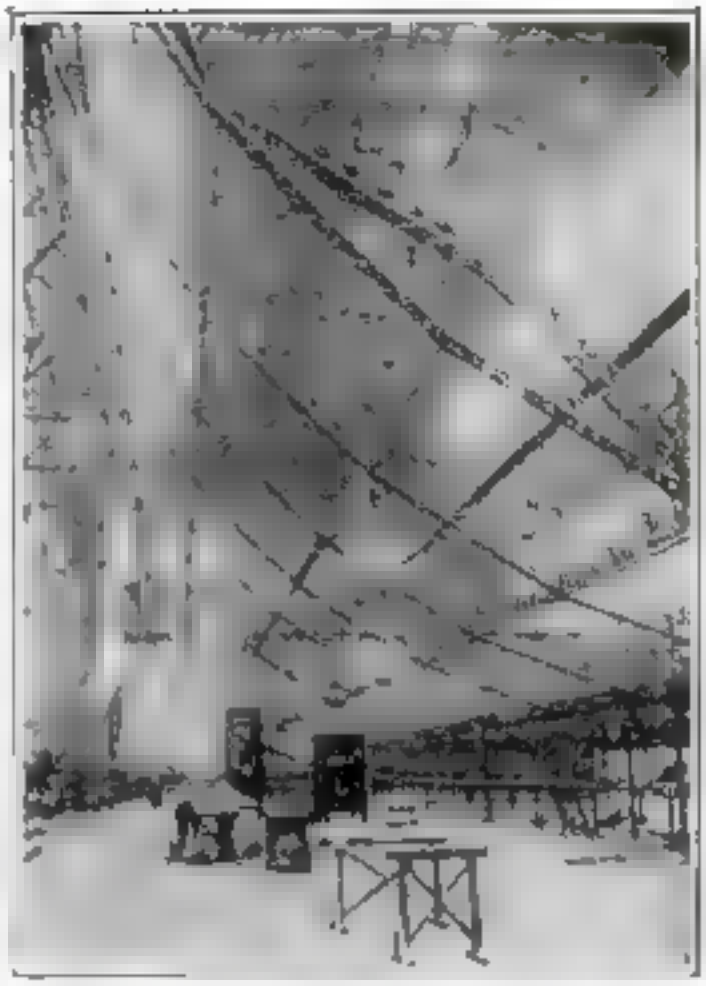
Now out on the promenade deck. It is thirty-six feet long and seventeen feet wide, on both sides of the passengers' saloon. A broad and strong walk, it extends from the sides of the cabins over to the huge "view windows." These are sections of clear plate glass rising outward at an angle of forty-five degrees. Easy chairs and tables are here for those who would sit and watch the panorama unfolding below. At night you will dance on this polished deck to radio music from New York and London

HALF of the cabins are on this deck, half on the deck above. We go down the last flight of stairs to the crew's quarters. Here are the captain's cabin, the chart room, and the quarters of the three navigating officers, the coxswain, the elevator coxswains, the riggers, the fuel tender, the chef, and the stewards. Their dining room is just below.



An actual photograph of the saloon in the interior of the *R-100*. One would think the picture was taken in a hotel or some great ocean liner

DANCING, Real Beds, and Hot and Cold Water Are Among the Luxuries of the Great Sky Liners Being Constructed for Trans-Atlantic Passenger Service. The Trip Will Cost the Traveler $400 and the First Flight Is to Be Made in Early Fall



The huge framework of the German *LZ 127* being built by Dr. Hugo Eckener builder of the U.S. *Akron*. This Zeppelin may beat the *R-100* to America

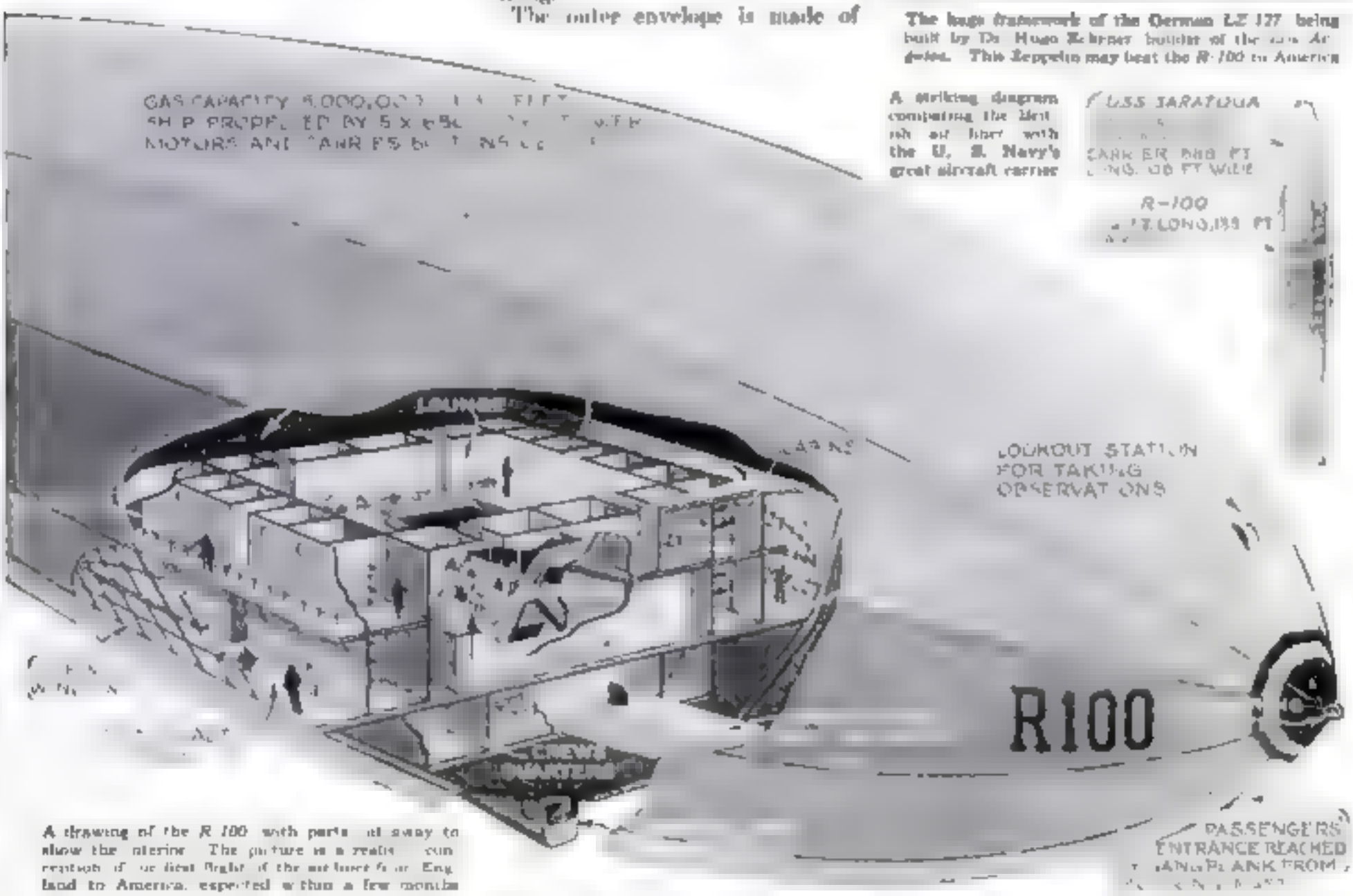
Down a ladder to the control car where the helmsman is at the wheel and the captain-commander stands over his instruments. Immediately aft is the wireless cabin, with a radio operator on duty night and day.

Another gangway runs along just above the keel to the amidships and after engine cars, and to the freight rooms between them. But passengers are not permitted to wander that far. There is plenty to see up above, to be sure!

quarters, and two large ventilating shafts provide a constant circulation of fresh air.

The interior of the great hull resembles the skeleton of a modern steel skyscraper with its maze of beams and girders and braces. Whereas the earlier airships were made of duralumin girdering, the framework of the *R-100* is of duralumin tubing, ten miles of it, remarkably light and enormously strong.

The outer envelope is made of



A drawing of the *R 100* with parts cut away to show the interior. The picture is a realistic conception of the first flight of the sister ship from England to America, expected within a few months

A striking diagram comparing the British air liner with the U. S. Navy's great aircraft carrier

The structure housing these three decks is slung from the framework of the hull. It is fifty-three feet wide, thirty-six feet fore and aft, and twenty-seven feet high. The passengers' quarters are completely contained within the dirigible proper, and only the control car, set directly under the keel, and the three engine cars are exposed. The framework of the structure, reinforced with duralumin at points of greatest stress, is built of fireproofed balsa wood and fireproof fabric. A tight fabric ceiling keeps gas from escaping down into the passengers'

two hundred and twenty-three thousand square feet of specially treated fabric. Up in the framework are the fifteen mammoth gas envelopes which give the ship a gas capacity of 5,000,000 cubic feet.

The six engines, each of 650-horsepower, are the Rolls-Royce Condor type. There are two in each of the three engine cars—two abreast on port and starboard of the lower frame, and the third further aft, slung below the center line. In these cars also are the smaller motors for lighting and heating the ship and for driving the dynamos.

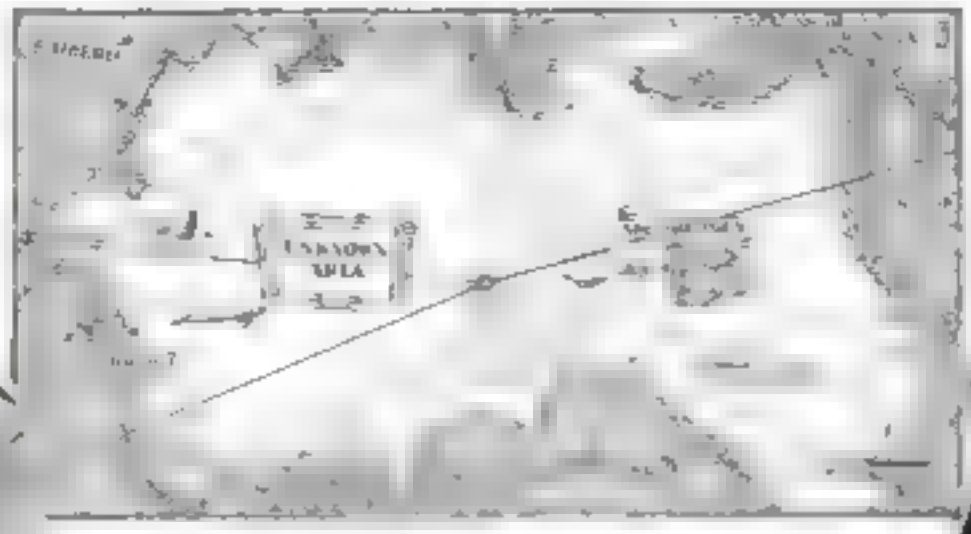
Specially-made tanks in the rear of the ship hold fifty tons of fuel. At the stern are the upper and lower rudders, upper and lower fins, the two "elevators," and the elevator fins. In the bow, above the mooring eye, is a lookout station, reached by a ladder, from which the navigating officers take their observations.

Thus is the good ship *R-100*, in truth a three-story "flying hotel," destined, unless all signs fail, to be the first across.

The makers of the German passenger dirigible, *LZ-127*, still hope to be first, but delays in (Continued on page 122)

Airmen Again Fight Arctic

General Umberto Nobile, builder and navigator of the *Norge*, who constructed a new and better dirigible to beat Captain Wilkins to the goal



The million square miles where two nations seek land

Captain George H. Wilkins, veteran explorer who chose a monoplane for the race to explore the mysteries of the unknown Arctic region

Man Against Man, Nation Against Nation, Dirigible Against Plane, and the Unknown Arctic Against All

By BURT M. McCONNELL

TWO men prepared to fly this summer into the last "Unknown Region" of the frozen north, prepared for a hazardous race to explore the top of the world to read the secrets of the north polar basin.

One, in a monoplane, carried the Stars and Stripes. The other, in a dirigible, the Italian flag, to plant on whatever land he may find.

Captain George H. Wilkins, veteran of two Arctic expeditions, commanded the plane, and General Umberto Nobile, Italian aviation expert, designer and commander of the dirigible *Norge* that flew over the Pole, his new ship, the last word in dirigible construction.

They planned to start from opposite sides of the world—Wilkins from Point Barrow, Alaska, northernmost tip of the American continent; Nobile from Spitsbergen, almost midway between Greenland and Norway. Their announced objective was an unexplored area 1,000,000 miles in extent between Alaska and the North Pole.

It is a contest between the plane and dirigible, between the American and Italian flags. But both could win, each without the other knowing it!

The area which beckoned them is almost a third the size of the United States. Either could land and plant his flag, claim whatever territory his eye encompassed, and be hundreds of miles from his aerial rival.

Whether land exists in this vast unknown region has long been a moot question. Arctic legends say it holds the "Lost Continent." Old mariners say it is another Sargasso Sea in which icebound ships, locked in the ice, sail endlessly around the Pole.

It is quite as important to science, Dr. Isaiah Bowman, director of the American Geographical Society has said, to know that land does *not* exist there as to know that it does. The few proofs that are offered tend to indicate that land in some mass, an archipelago at least, does lie in that desolate region.

IF LAND is found it may mean the opening of new lanes of commerce, of time-saving flights over the top of the world, and a system of transpolar air travel. The nation possessing such land, a requisite for polar air bases, would hold a strategic position.

In the absence of unquestioned proofs, scientists have for years studied all available data relative to the geography of this mysterious waste. Their findings, however, have been relatively meager.

The late Dr. R. A. Russell, American geographer, attracted attention some time ago by offering a table of the tides in the Arctic Ocean as proof that a large mass of land lay to the north of Alaska.

Vilhjalmur Stefansson on one of his last ventures into the Circle took meteorological observations which indicated that the prevailing winds along the north coast of Alaska come from a common center or pole. These "wind poles" are usually higher than the surrounding territory, a fact which led scientists to believe land may lie "somewhere in the center of the ice pack."

MASTERS of old Arctic whaling ships point to the springtime cruises of the bowhead whale as indicating that at least an archipelago exists far north of Alaska. This whale, which feeds only in shallow water, goes north in the spring through the Bering Strait and sets a course to the eastward of Wrangel Island. Reaching that point his whereabouts become a mystery until he is seen, weeks later, off the west coast of Banks Land, 900 miles to the east. If no land exists in that unexplored region, the old whalers ask where does the bowhead find shallow water in which to feed during his long journey?

Geese and ducks have been seen flying directly north from Point Barrow during the early summer. A few months later they fly back with their young. They must have a feeding ground in some place not yet discovered.

No one will hazard a definite statement as to this northern vastness. One guess, explorers admit, is as good as another. They will recite the saga of the "Lost Continent," handed down through hundreds of years by the natives of Siberia, or repeat the tales of old Arctic skippers of a "phantom fleet" of scores of whaling vessels, gripped in the eternal ice pack. Stories, these, to fire the imagination—to challenge the flying explorers on their dangerous quest!

It is true that the *Norge* cut a swath 100 miles wide across this unknown region when she flew over the Pole from Spitsbergen to Point Barrow two years ago, and that her lookouts sighted no land. But the dirigible flew in a dense fog that all but obscured the vision. On the other hand, Commodore Robert E. Peary, after his discovery of the North Pole in 1909, declared the (Continued on page 137)

A steam turbine locomotive of a type being tried extensively in Europe. The windmill-like turbine (on the front) is driven by powerful blasts of steam

Huge New Super-Locomotives

Three-Power "Iron Horses" of Electricity and Incredible Steam Pressure Make Giants of a Few Years Ago Look Like Toys

By GEORGE LEE DOWD, JR.

RECENT tests of a three-power locomotive, first of its kind, emphasize the amazing progress that locomotive designers have made since their chugging toys of nearly a century ago. No throttle does the engineer of this modern "iron horse" grasp. Instead he closes one of a row of electric switches and the steel giant glides forward and picks up speed. A click of relays, a flash of light in the cab—and now it is drawing its silent power from the third rail, instead of from its own huge storage battery.

Styles for locomotives in 1928 reveal radical departures. Electric engines like this versatile new one built for the New York Central Railroad herald a new era of smokeless and noiseless travel. Steam engines bigger than ever before challenge them. Meanwhile the Diesel locomotive looms as a formidable future rival.

The Central's new electric is for service in New York freight yards where the tracks are as yet only partly electrified. Its huge storage battery—one of the largest ever put in a locomotive, a seventeen-ton affair as heavy as a small dwelling—will drive it where there is no outside power. An oil engine and dynamo provide power when the battery needs recharging.

One of the outstanding novelties—incidentally, the heaviest locomotive Europe has built—is an engine whose driving wheels are not beneath it at all, but under double tenders at the front and rear. This oddity is built by L. A. Maffei, of Munich, to twist its lunged frame over the South African Railway, noted for its tortuous curves.

With a gasoline engine like an automobile's where you would expect a boiler to be, and a sawed-off "smokestack" that serves as an exhaust pipe, a new locomotive recently created a sensation when exhibited at Los Angeles. Generally gasoline fuel is too expensive, but for short runs with a few cars, where oil is plentiful, this odd engine is expected to pay.

Steam turbines—whirling "windmills" driven by powerful jets of steam—have long since replaced cylinder steam engines in great power houses; now they are being tried in locomotives in Europe.

When the locomotive *Horatio Allen* was built for the Delaware and Hudson Railroad three years ago, some engineers considered its 350-pound steam pressure excessive and dangerous. But it gave greater power and saved fuel, and now the *John B. Jervis*, with a pressure of 400 pounds, is in use by the same road. Meanwhile a locomotive on the German State Railways develops pressure of 900 pounds, and the exhaust is reused in additional cylinders. Such high pressures tomorrow may be the rule.

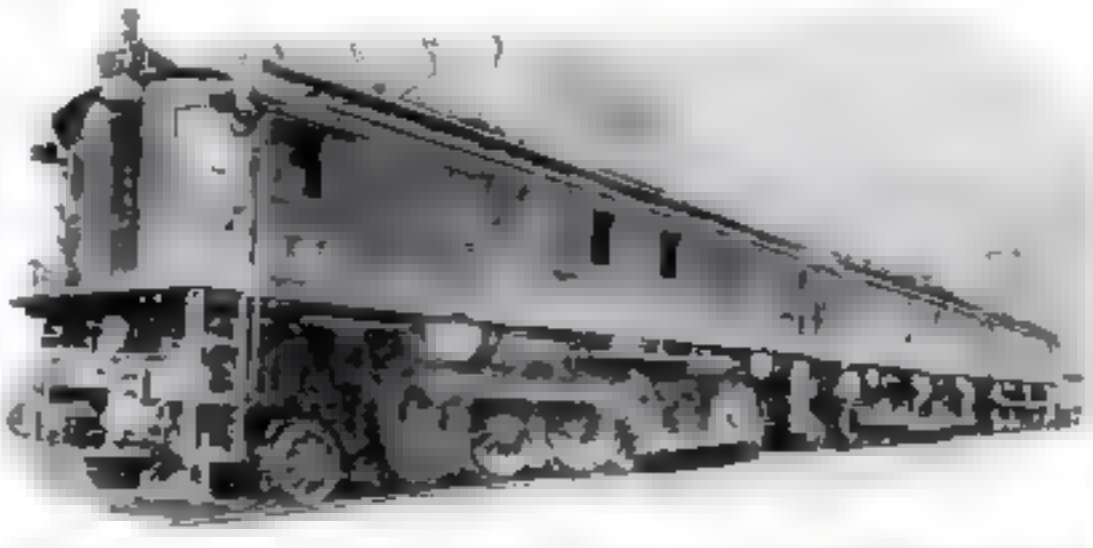
THE largest electric locomotive in the world is the mammoth on the Virginian Railway that yanks strings of ponderous coal cars from Mullens, W. Va., to the coal docks at Roanoke, Va. From his compartment in the front cab, the engineer can see the engine's rear end, more than 150 feet away from him, rounding a curve. His locomotive is in three sections so that it can turn its great length on a sharp curve easily. A single engine of this type hauls a string of loaded freight cars nearly two miles long, weighing 9,000 tons! And on the Cascade Mountain route in the state of Washington, two-piece electric locomotives of the same general type whisk huge trains up terrific grades. Four sections could be joined together to make a still greater locomotive.

Another huge locomotive of a novel type is the Diesel-electric recently adopted for light traffic by the Chicago and Alton Railroad. It has passenger compartments and a baggage room and hauls one or two standard passenger cars when traffic warrants at speeds up to sixty-eight miles an hour.

Search for new fuels cheaper than coal has speeded the development of the Diesel engine used here and in other of the new locomotives; and many engineers see it as the leading engine of the future. The Diesel is substantially like the motor in your automobile, adapted to use cheap oil for fuel instead of gasoline. It is an internal combustion engine whose fuel explodes in its cylinders. Due to the terrific compression of its flying pistons, it explodes its oil fuel without spark plugs. Such a Diesel engine is generally coupled directly to an electric dynamo, and runs nearly at full speed all the time. The locomotive can be controlled by a switch; there is no need of "shifting gears" for varying loads.

In Germany, a new type of locomotive has successfully burned powdered coal, which may be prepared from the cheapest grades. It sprays furiously burning coal dust into the fire chamber.

These are a few samples of what the locomotive engineer drives in 1928. A long way the "iron horse" has traveled since George Stephenson in the original *Rocket* chugged between Liverpool and Manchester, England, just ninety-nine years ago.



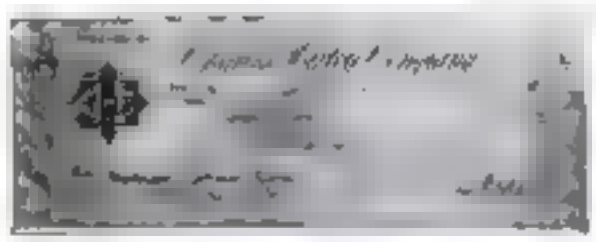
The world's biggest electric locomotive—150 feet long. In three sections, it bends to negotiate curves, hauling 9,000-ton trains, two miles long, on the Virginian Railway

Catching Crooks *with a* Camera

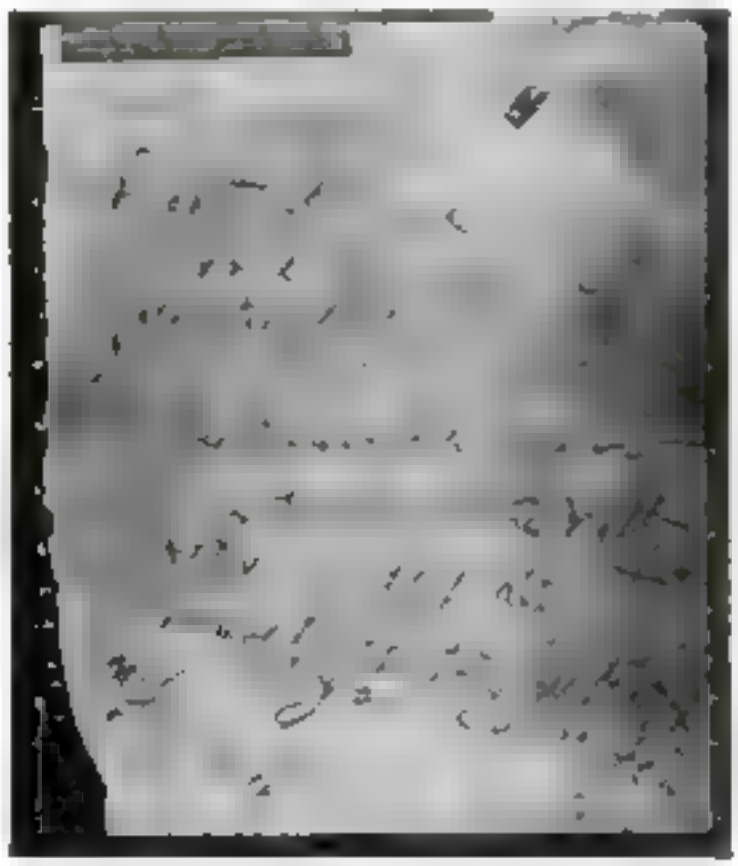
A $39 note raised to $500. The trick was detected when ultra-violet light revealed the true amount in invisible ink, as shown below

True Tales of Modern Master Detectives Who, With Light Rays and Chemicals, Solve Crime Mysteries—Science Beats Sherlock Holmes in Finding Hidden Clues

By
HOWARD McLELLAN



Photomicrograph of a check, showing fingerprints in acid by the cashier who failed to wipe the acid from his finger tips after erasing the payee's name and substituting his own. Below: Reverse side with erased signature faintly discernible at left



Photomicrograph of false suicide note forged by woman who killed her husband. It shows traced-over signature and evidences of erasures. The woman finally confessed

ASTRIDE a weary-footed pony a gray-bearded mountaineer rode through the main street of the old Spanish town of San Felipe in the chaparral-covered foothills of southern California. A tattered and shapeless hat shaded his grizzled features from the midsummer sun and hid his face from the men who stood in knots along the street talking with violent animation about the cold-blooded murder of the two Rosencrans brothers, shot to death the day before in their cabin twenty miles up a lonely gulch. A deer rifle teetered from the coat strap on the pommel of his saddle. His head drooped and his shoulders swayed to the pony's lazy jog. Presently he reined the animal into the Court House yard and, a miserable and dejected figure, tottered up the steps to the sheriff's office.

"Guess I'm the man that killed my brothers," he sobbed as his head fell across his weather-hardened arms on the desk railing.

"You guess!" exclaimed the sheriff, amazed. "Don't you know?"

He caught the old man's chin and raised his head until he could look into its tear-filled eyes. A breath heavy with the fumes of raw moonshine whiskey came with the answer.

"Must 'a' been me . . . ain't sure . . . must 'a' been me . . . must 'a' "

"But we've got a fellow in jail for the killing," the sheriff said.

STILL the old man maintained his probable guilt. He had awakened in the cabin after a night of heavy drinking to find his brothers dead and the rifle clasped in his arms. He insisted on being locked up. In his cell that night he tried in vain to kill himself.

Meantime a young Mexican in an adjoining cell also lay sleepless, dreading the doom the old mountaineer had fashioned for himself. At dawn the Mexican looked out his cell window and saw a crowd of angry townsmen pointing up to the cross arm of a telephone pole. Two carried lariats. There was talk . . . "String him up there!" . . . "bring the 'greaser' out!"

The young Mexican had not yet been formally accused of the murders, but he had been told that his thumb print had been found on one of the whiskey flasks from which the brothers had been drinking.

Out of this tragic situation there developed one of the weirdest cases in the annals of American criminology. While lynchers were getting ready to string up a man for a crime which another believed he had committed, and human faculties had failed to fix the crime on either, there stepped into the picture a man who had more faith in a microscope and an ordinary camera than in the human eye.

This man, Chauncey McGovern, is a well-known San Francisco criminologist whose specialty is looking at bits of evidence—human hairs, fingerprints, footprints, papers—through his cameras and, by an uncanny manipulation of chemicals, photographic films and papers, getting at the hidden truth of things which the human eye cannot perceive.

McGovern dusted the outside of the whiskey flask with fine aluminum powder, then filled it with black ink. The fateful thumb print stood out clearly. Under a microscope it looked precisely like the thumb prints he had taken that day from the Mexican. Then he "took" the thumb print through the photomicrographic lens. In this process, details which even the microscope had failed to reveal were brought out—details that proved the imprint on the flask was not that of the Mexican's thumb!

BROKEN ridges and small "islands" were found in the print on the flask, but no such details were made by the Mexican's thumb. He was immediately discharged. The old mountaineer, too, was freed, and subsequent developments have convinced the authorities that they were right in absolving both men from participation in the murders.

Thus it is seen that justice, which is sometimes accused of being blind, has in the sciences of photography and microscopy allies with unfailing sight. Indeed, the near tragedy in San Felipe indicates that these sciences, aided by recent developments in light, are approaching the point where the fine line of doubt in many instances of disputed evidence will disappear. This is illustrated by another chapter from McGovern's book of mysteries which are, of course, no longer mysteries.

A San Francisco manufacturer found his office had been entered and chairs broken, typewriters smashed, desks scratched, and papers smeared with tobacco juice. Nothing had been stolen; vengeance seemed to have been the motive.

One clue was found but proved to be too remote to lead anywhere. The marauder, wearing gloves, left not a fingerprint. Clever—but he still had feet!

McGovern threw a strong light on the top of a mahogany desk, rigged his micrographic camera above the desk top, and "shot" down at it. Even under a magnifying glass, the highly polished surface revealed nothing, but the all-seeing lens showed the prints of a leather shoe sole and rubber heel where the culprit had stepped on the desk to reach filing cases on a high shelf.

By using a panchromatic film and a G-filter in the camera, a negative was produced which gave the actual size of the shoe—number nine!

DETECTIVES checked up on all wearers of number nine shoes in the factory. A disgruntled foreman was found who wore that size. McGovern put on his shoes, stepped into thinly laid lampblack, and walked on several sheets of white paper, making prints corresponding with those on the desk.

The foreman was convicted by a jury that saw the test repeated in the courtroom.

The largest item in the nation's bill is the loss at the hands of check operators—the printers of counterfeit checks, check raisers, and forgers—all members of the tribe known to the underworld as "paper hangers." Each year they take more than $60,000,000 from the American public. The schemes they devise to get easy money frequently go undisclosed for years.

Except for McGovern and his microscopic camera, one of the most baffling check mysteries on record might have gone unsolved to this day. After twenty years of friendly business intercourse, a large Pacific Coast wholesale paper firm came to loggerheads with a customer over what appeared to be unpaid bills of more than $100,000. The customer firm produced its payment checks, properly endorsed by the paper firm and marked paid and canceled by the bank through which they had passed. Yet the firm to which the money was due insisted it had never received any of the amounts.

Chauncey McGovern at his glass topped, so-called ghost table on which he makes light and the micrograph camera reveal secrets of crime documents

FINALLY the heads of the two companies met. "Somebody's lying," said one. "Yes," said the other, "and it isn't us." So the wholesaler sued and the customer called in McGovern. A few days after word got out that the criminologist was on the job the unsuspected cashier of the customer firm killed himself. The $100,000 had found its way into his pockets through an amazing check manipulation. The secret of his scheme was thought to have been buried with him, but the camera brought it to light. The cashier had made out the checks as usual and had his president sign them. Then with chemicals he had erased the paper house's name as payee, substituted his own, and cashed the checks. When they came back canceled from his firm's bank he had erased his own name and endorsements and in their place had forged the name and endorsements of the paper firm. The checks were then placed with others in the dead files.

Examination of the checks by the eye and microscope failed to disclose the alterations. McGovern put them under his micrographic camera. By using a hard glossy contrast photographic paper and a process film, the eradicated signatures of the cashier were brought out.

By the same process a mystery was untangled after the foreman of a lumber mill was found dead in his home, a revolver by his side and a "suicide note" in one hand.

"The handwriting is all his," said the prosecuting attorney.

"That remains to be seen," said McGovern. He went into his dark room and emerged with a photomicrographic negative of the note. The only writing in the foreman's hand was his signature.

The criminologist accused the foreman's wife, who retaliated by suing him for libel; but before the suit came to trial, she confessed and began serving a twenty-year sentence for his death.

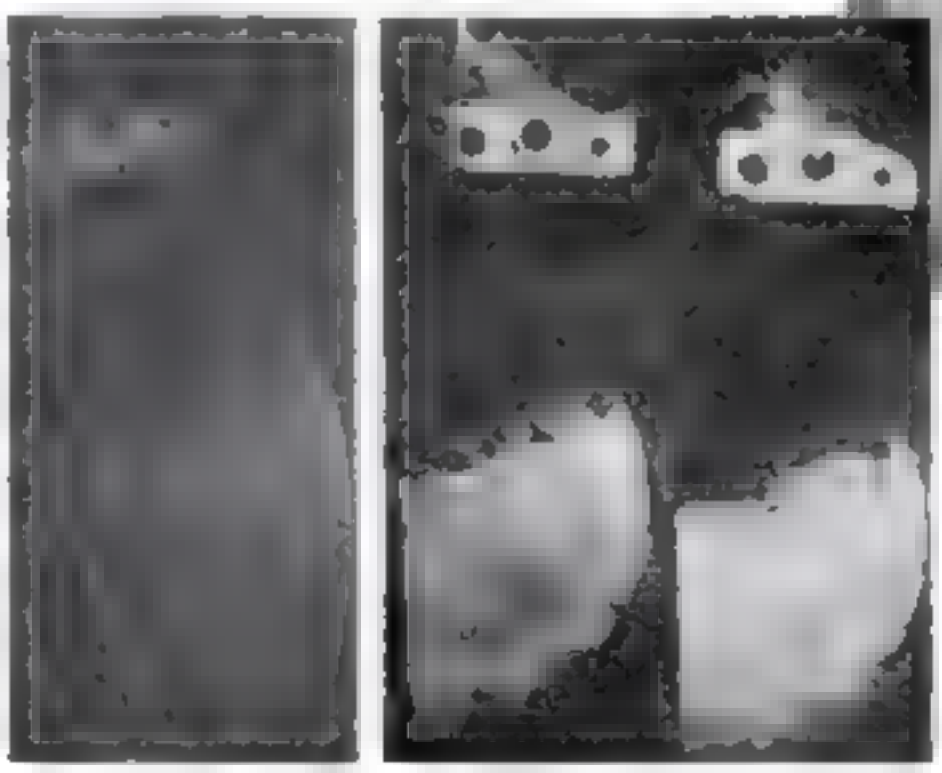
SHE had erased an old note from her husband, all but the signature, which she traced over and above which she wrote the suicide note. The camera had recorded enough of the erased letters to expose the deceit.

Where the camera is making progress in the scientific detection of crime, an ultra-violet ray lamp is lending aid to crime prevention.

A short time ago a traveling "check printer" skilled in the crooked art of faking pay-roll checks used by large corporations turned up in New York City. One of the fakes fell into the hands of Dr. Herman Goodman, who had such an ultra-violet lamp, used to detect impure chemicals. In his possession he chanced to have a check given by the company on whose account the fake check had been drawn. Holding the two checks under his lamp, he saw an invisible safety symbol like a water mark, in the paper of the genuine check; the fake had no such symbol and its paper under the penetrating rays was of an entirely different texture and color. The ultra-violet rays had caused a fluorescence to appear in the genuine check and the protective markings printed in a secret ink were brought to light.

Among new inventions, the Knowles grid-glow tube strikes terror to the bandit heart. The faintest shadow passing near the tube makes it sound an alarm. Recently burglars in an attempt to enter a jewelry store raised a window curtain. The tube caught the movement of light and registered an alarm.

A photomicrograph of the thumb print seen through the peephole of cages two innocent men held on murder charges

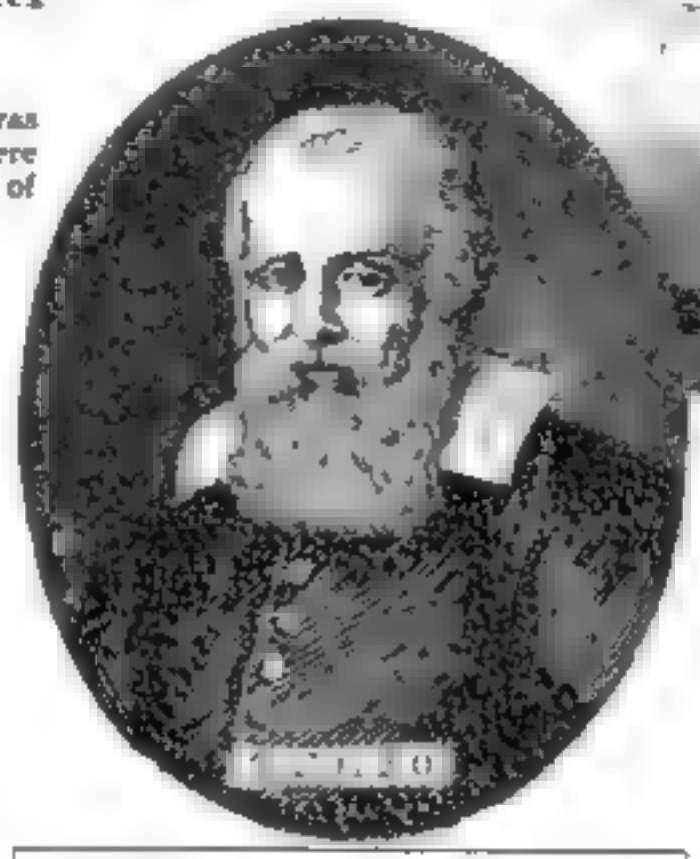


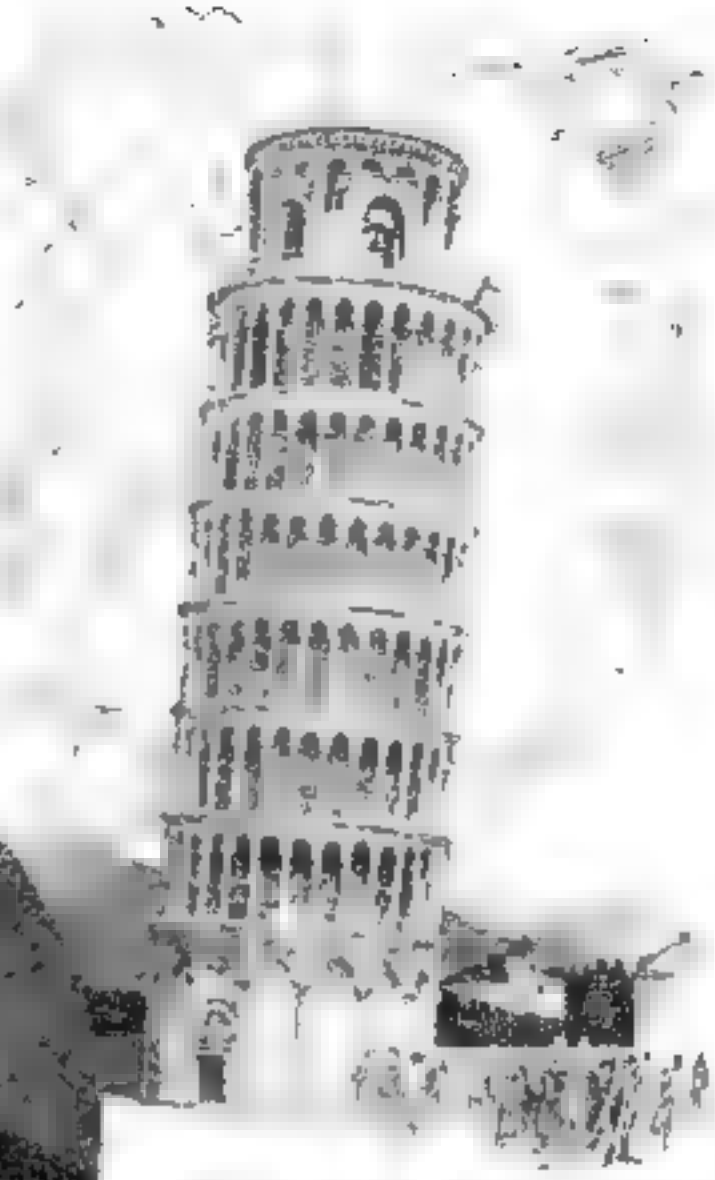
Left: Vandal's shoe print detected by photomicrograph on a desk after study with a magnifying glass had revealed nothing. Right: Test footprints that were made with the suspect's shoe and established his guilt

Galileo Galilei, "Immortal Fool"

Paid in Persecution, He Made Over Half of Science, and His Inventions Changed the World's Entire Course

By ARTHUR A. STUART





Galileo amazes scientists and gains fame that will endure longer than the tower of Pisa by dropping stones from it to disprove the theory that weight determines speed of falling bodies

ABOUT the time New York was born, a city of 380 souls, there lived near the Italian city of Florence a broken old man, banished from the world, an exile within his own house, soon to die of fever. Once the vigor of his mind had overthrown the dictates of wise men, had commanded the respect and enmity—of the most powerful; now he was racked with pain and misery. Once his keen eyes had peered farther into space and seen more wonders than any man; now those eyes were blind. With groping hand he wrote:

"Alas, your dear friend and servant Galileo has been for the last month perfectly blind, so that this heaven, this earth, this universe, which I have enlarged a hundred thousand times beyond the belief of the wise men of bygone ages, henceforward is for me shrunk into such small space as is filled by my own bodily sensations."

Today, after nearly three centuries, this tragic figure is revered as one of the immortals of science. In a modern world of wonders which grew largely from his restless brain, almost every school child knows his name and deeds—Galileo Galilei, the inventor who gave us the pendulum, thermometer and telescope, the astronomer who first revealed the majesty of countless stars in boundless space, the philosopher who broke the shackles which had retarded the progress of knowledge for centuries, and who put a self-exalted world in its place as a little rotating ball in a mighty creation of suns and planets.

FROM the day when with the beat of his pulse he timed the swinging cathedral lamp in Pisa until his death, Galileo never lost enthusiasm for his experiments.

Luther Burbank, when a young man, used to return from his walks with his handkerchief gone, his shoes flapping, and the end torn off his necktie. He would explain that the string with which he marked unusual wild flowers in order to find them at seed-time had given out. So he had used his shoe strings, strips of his handkerchief, and bits of his necktie for markers.

Great men of science find their work so interesting that they give it their whole attention. And that trait is commonly called genius.

THE genius who did all these things achieved greatness by daring to kick over the traces of tradition to discover facts and prove them. Throughout a dramatic life he was scoffed at and even persecuted for his pains. But the net result was to give to future generations a new understanding of the laws of energy and motion, without which mechanical marvels of our time might never have been possible.

Galileo began life in 1564, the son of an impoverished Florentine nobleman. He was a "regular boy," whittling, hammering, contriving ingenious mechanical toys out of odds and ends. He was especially fond of drawing and playing the lute. Some day, he thought, he might become a great artist.

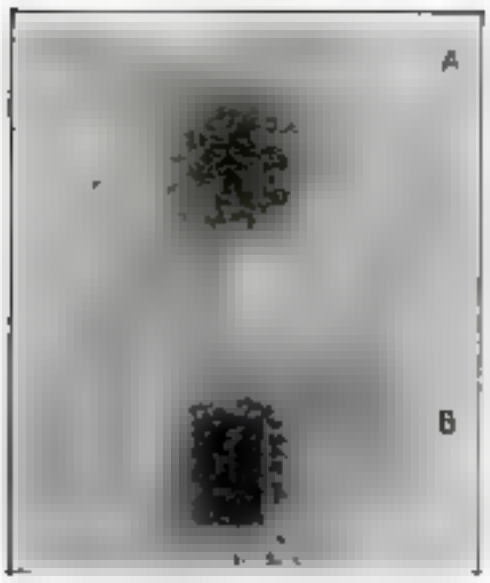
But his father thought otherwise and, scraping together his meager savings, sent the lad, at seventeen, to the University of Pisa to become a physician. Here Galileo was quickly marked among his fellows for originality. He was everlastingly curious. He refused to accept anything as fact, unless shown the proofs. He disturbed his instructors. They, like scholars for centuries before them, accepted without question the words of Aristotle as to the foundations of natural law. Who was this bold young upstart? "Fool," they said. "do you think yourself wiser than Aristotle?"

But the mind of Galileo drove on. One day he overheard an instructor teaching geometry to court pages. A passion to master the subject fired him. Forgetting his medicine and his father's admonitions, he plunged through six books of Euclid and the works of Archimedes, then asked for more.

FROM this study emerged the inventor. One evening in the cathedral of Pisa the swinging of a high chandelier caught his attention. Closely he watched as its distances of travel gradually diminished. Suddenly he observed a significant fact—no matter how wide the arc described by the chandelier, the time consumed in one complete oscillation was always the same. Here, he saw, was a new principle which might be used to control the measurement of time. But he must verify his observation. Returning to his room, he whittled out a crude contrivance of cog-wheels controlled by a swinging pendulum. It worked. First he applied his discovery to aid physicians in measuring the pulses of patients. Later he constructed a clock. Thus, out of a swinging lamp and a brain, came the forerunner of modern pendulum timepieces.

Meanwhile Galileo's work in mathematics and physics was receiving recognition. Friends called him "a second Archimedes." Treatises on the center of gravity and on the behavior of floating bodies won for him, at twenty-five, a professorship in mathematics in the university.

But as his fame increased, so did his enemies' people (Continued on page 140)



Iron filings drawn (above) by ordinary magnet and (below) by the new hollow magnet with half the weight, twice the power, and more uniform force

MAGNETS— Strangest Tool of Man

Discarding nine steel strips composing a solid magnet Joseph Zacher, German, makes a hollow magnet twice as strong of the remaining four strips

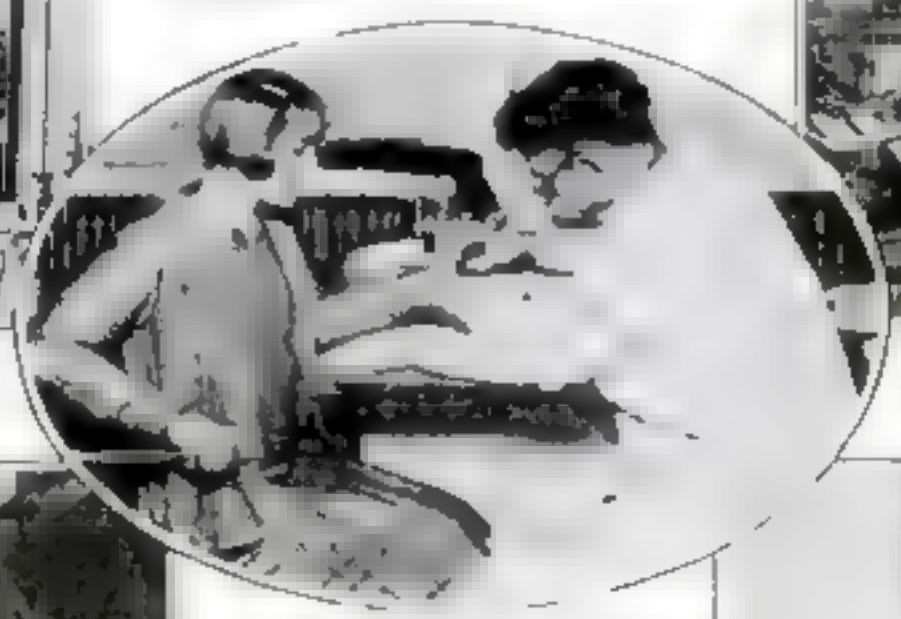
A MASS of steel rises upward in apparent defiance of gravity—you can see it on the cover of this magazine—to drop neatly to the spot where it is wanted. From a pile of ore great chunks of dross leap up as if alive and sapphires and diamonds remain. These are but samples of man's achievements done upon from the toy horseshoe magnet of his childhood.

Magnets serve or soon telephone your motorcycle or automobile your doorbell your radio loudspeaker or virtually everything you use that's electrical.

And the end is not yet. In the Bureau of Standards Washington D C a huge magnet helps study the mysterious atomic structure of rare metals. In England P. I. Kapitza plans to short-circuit all the power of a four-ton dynamo through a two-inch coil, making "immeasurably the most powerful magnet in the world."

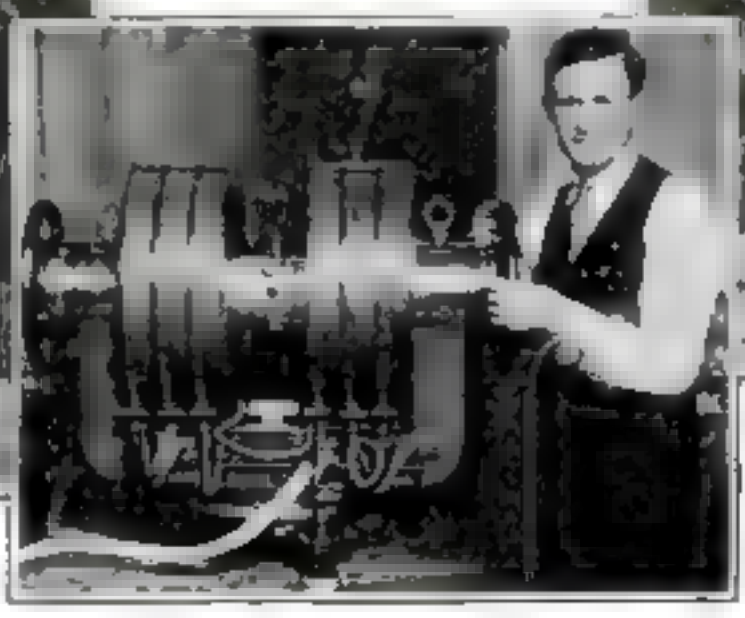
A big magnet in a Chicago plant moving with ease half a ton of steel staves like so much straw from a delivery car

Smashing obsolete U. S. ships for sale at Alexandria, Va. A magnet drops a 2-ton steel bar on the worn-out hulks



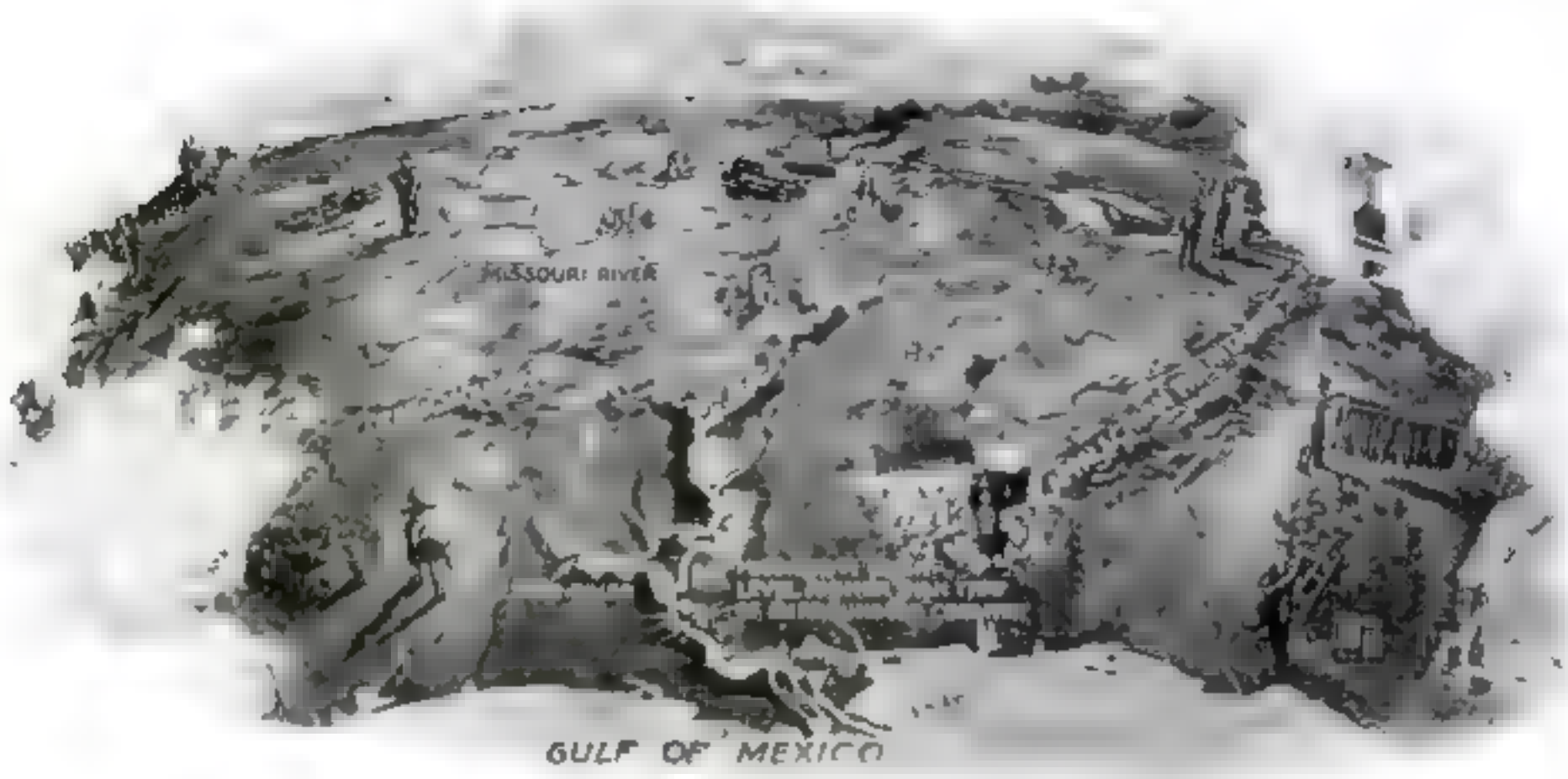
Drawing metal splinters from an injured worker's hand with the robalt steel magnet devised by Dr. R. C. Harrington of the Chicago Western Electric Co.

Six workmen hang from a steel bar held by a magnetic pulley while a seventh with iron-soled shoes, hangs from it head down



Half a ton of iron filings rush to a magnet to be carried away by it when a crane lowers it into their bin in Paterson, N. J. junk yard

W. F. Meggers of the U. S. Bureau of Standards and his powerful electromagnet which is cooled by water in its hollow windings



This map exaggerates the height of the river channels in order to make the Mississippi problem clearer

TAMING THE MISSISSIPPI

By MYRON M. STEARNS

A HOUSE swirls along in a mighty current. A man clings desperately to the roof. A huge uprooted tree courses alongside. Drowned cattle and horses sweep along in the rush of water. On either side an inland sea stretches thirty miles, wide as Lake Michigan with a devastating current a hundred feet deep down the middle.

'The Mississippi River in flood!'

Will this be the last? How are those hundreds of square miles of mad water in a flat, densely populated plain to be controlled? The states most vitally affected have appealed desperately for help. Congress spent weeks debating the problem and set about spending hundreds of millions of dollars to meet it.

For more than a year scientists have been grappling with it. It is the greatest challenge of Nature that science has ever accepted. Can science win? How? Those are the questions whose answers the editors of POPULAR SCIENCE MONTHLY set me to find for you.

The Mississippi valley flood problem is not, as many suppose, the result of man's interfering with Nature. It is all Nature's own doing. Long before man appeared in the Mississippi valley, the floods were there. In 1543, according to the Spanish historian La Vega, when the flood took forty days to reach its height, only the tops of the tallest trees were visible for twenty leagues on either side of the Mississippi. The greatest flood, according to traditional belief, was in 1785. The greatest of which there is definite record was in 1844, when the water at Cairo was two feet higher than last year. And in 1844, with virtually no levees, the waters spread over the whole vast valley.

I went to Boston to consult Alfred C. Lane, Professor of Geology at Tufts College, an authority on flood control. In 1889 he was hydrographic engineer on the Rio Grande. He has had a long, successful record as State Geologist of Michigan and is vice president of the Geological Society of America and a member of the National Research Council. "Why," I asked him, "does the Mississippi with other rivers in its valley, make so much trouble? Others don't. The Colorado doesn't—or didn't until man interfered with its natural course."

"The explanation is not so difficult," Prof. Lane said. "Geologically speaking, the whole Mississippi valley is new land. It is still rising from the bottom of the sea. In ten years it may rise an inch, in a hundred, a foot or two.

"Geologists' opinions differ, but the dominant theory is that the earth's crust in the whole region around where the Great Lakes now are was depressed by the tremendous weight of ice in the glacial period and is now gradually springing back into place. Thus the lower valley, instead of being a true delta, made wholly by mud deposited by the river itself, is a plain raised by great natural forces across what once was the river's mouth.

"YOU can see today, five hundred miles inland, sand dunes that were originally on the shore of the Gulf of Mexico.

"The lower Mississippi valley is slowly being tipped upward, like a washboard being raised a little at the upper end!

"Across this flat valley," Prof. Lane went on, "the Mississippi has had to cut, through thousands of years, its twisting, shallow channel to the Gulf.

"Now to make it worse, a lot of the silt dug from the channel has never been carried out to sea. It has merely been piled on the land near the banks in the countless overflows. So the *middle* of the valley, where the Mississippi itself twists down, is now actually higher than the land at the *sides* of the valley."

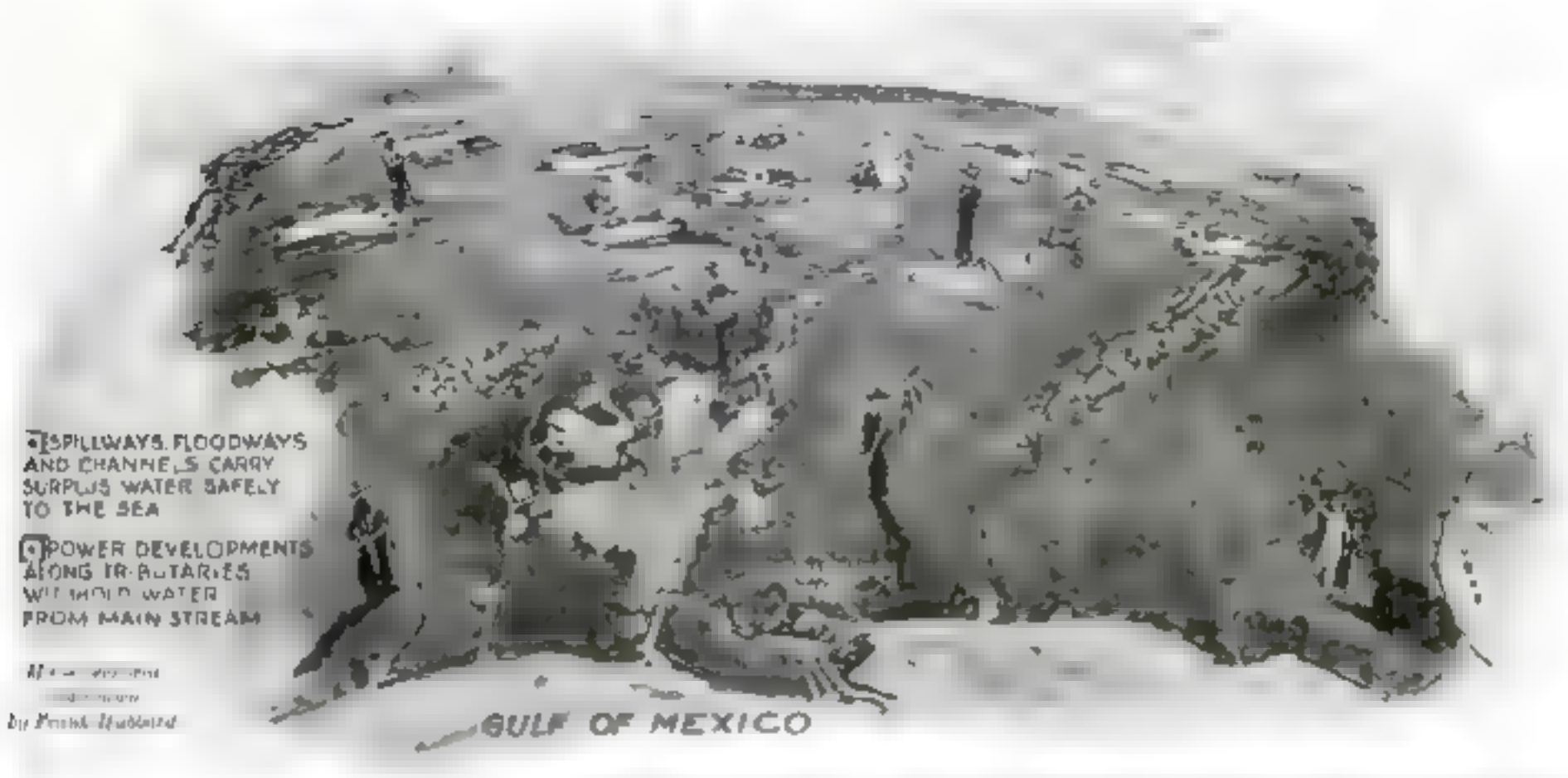
THUS it happens that hundreds of thousands of houses are ten to thirty feet lower than the river itself when it is in flood.

From the edges of the river, Prof. Lane told me, the land slopes away downward, fifteen or twenty feet in four or five miles, until you come here and there to smaller rivers and watercourses at levels lower than the Mississippi, and more or less parallel to it.

No wonder man has had trouble controlling the Mississippi! To all intents and purposes the river is flowing along a low ridge in the middle of a flat plain!

As Prof. Lane referred to the Merrimac and other relatively small rivers of New England, I realized that to a degree all flood control problems are similar.

Last year was unprecedented for storms and floods. There were floods even in mountainous districts all over the world, where such things are almost unknown—in the hills of New England, in the Engadine Mountains at the eastern edge of the Alps. In this country alone



The flood control measures are not located precisely, but approximately, merely to illustrate the plan

How Ages of Ruthless Flood Devastation Can Be Ended Forever and Murderous Water Made to Do Man's Work

the damage was more than half a billion dollars, and hundreds of lives were lost.

Every year, in one place or another, Nature smashes forth and overturns man's greatest efforts to control her. There is a cloudburst in Colorado! Unusually high tides back up in the Thames, and flood part of London! A great dam bursts in Pennsylvania or California!

Nowhere on earth, however, is the flood control problem greater than in the Mississippi valley, with its thousands on thousands of square miles of fertile farm land, where more than a million and a half people live in homes below the level of the river. Through science, Prof. Lane told me, those homes will soon be safe!

Man's first effort to control the Mississippi was by building levees. The first planters thus sought to protect their own plantations and passed the danger along to the next fellows. Gradually the levees were enlarged and extended until they now form a set of parallel banks long enough to reach from New York to Chicago!

They have cost, so far, more than $250,000,000!

THEN, last year, came the flood again to show their inadequacy. Every few years, after more millions have raised the levees another foot higher, a new flood overflows them! A stream as big as a barrel bursts through the side of the levee! A few minutes later it is a torrent! Great dikes crumble. A new crevasse is formed, perhaps miles wide. The river goes flooding away again across the plantations. Again, as in 1543, only the tops of trees can be seen for miles above the flood!

"For a hundred years," said Prof. Lane, "only this one effort has been made to control the Mississippi, but that is not enough. There is more than one way of skinning a cat."

"I suppose," I ventured, "one of the next steps will be to dredge a deeper channel."

"No," he said emphatically. "That's another popular misconception of the Mississippi problem. It's true that the channel gradually silts up, during low water, when the current is slow; but what people don't know is the amazing lifting power of a stream of water.

"Each time the speed of a current doubles, its lifting power multiplies *sixty-four times*. If water traveling at three miles an hour can lift or roll along a stone an inch in diameter, then by the time the current is rushing at twelve miles an hour, it can lift or roll a rock more than a foot through. In times of flood a river like the Mississippi dredges out its own channel. Usually, for every rise of a foot in the height of a great river like the Mississippi, there is another foot added at the bottom of the channel until bedrock is reached.

"Near Kansas City there is a place where the Missouri is about twenty feet deep. The bottom usually is another forty feet above bedrock. In flood times when the river reaches a forty-foot stage, all the mud in the channel is dredged out so that the stream is a hundred feet deep."

"THEN what," I wanted to know, "is the next big step to control the Mississippi, if levees and dredging will not avail?"

"Two additional useful measures are already contemplated," was the answer, "spillways and floodways. The 1927 flood showed their necessity, and their effectiveness as well. You remember how, to safeguard the city of New Orleans, the levee was dynamited and a great area below the city inundated. That, with modifications, is the idea of a spillway.

"When the river reaches a stage to endanger the levees, safety can be secured only by providing some outlet for the extra water. Clearly, it is better to provide an outlet at some given point than to let the river make its own break at some unexpected spot. Spillways here and there along the levees will take a share of the flood water—just as with reservoirs and dams—and prevent the river from rising beyond a certain stage.

"But that (Continued on page 126)

THE EARTH'S TIDES

A MOSQUITO, perched on a steamer, might tell you how solid and immovable was its resting place. All the while, the ship would be rising and falling in the water.

Men, walking on the earth's surface, think of it as solid. Yet the very continents we live on, like floating islands, are riding on a fluid layer below the earth's outer crust. They, like the mosquito's ship, rise and fall on waves that take centuries to reach a crest.

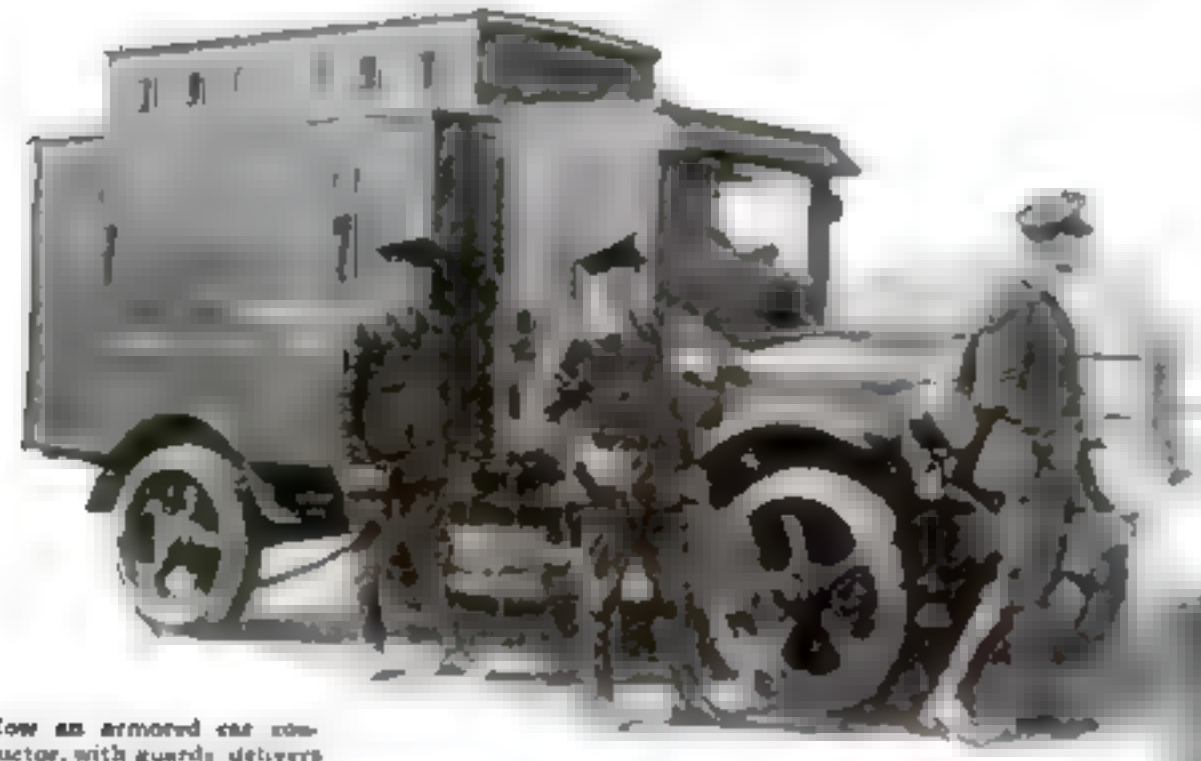
Mr. Stearns here tells, in a few words, a thrilling story of a moving continent. Centuries ago, ice, pressing down on the Great Lakes region, as your thumb presses down on a soft tennis ball, pushed it in. Now it is springing back and the whole Mississippi valley is slowly rising.

To understand this world we live in requires imagination.

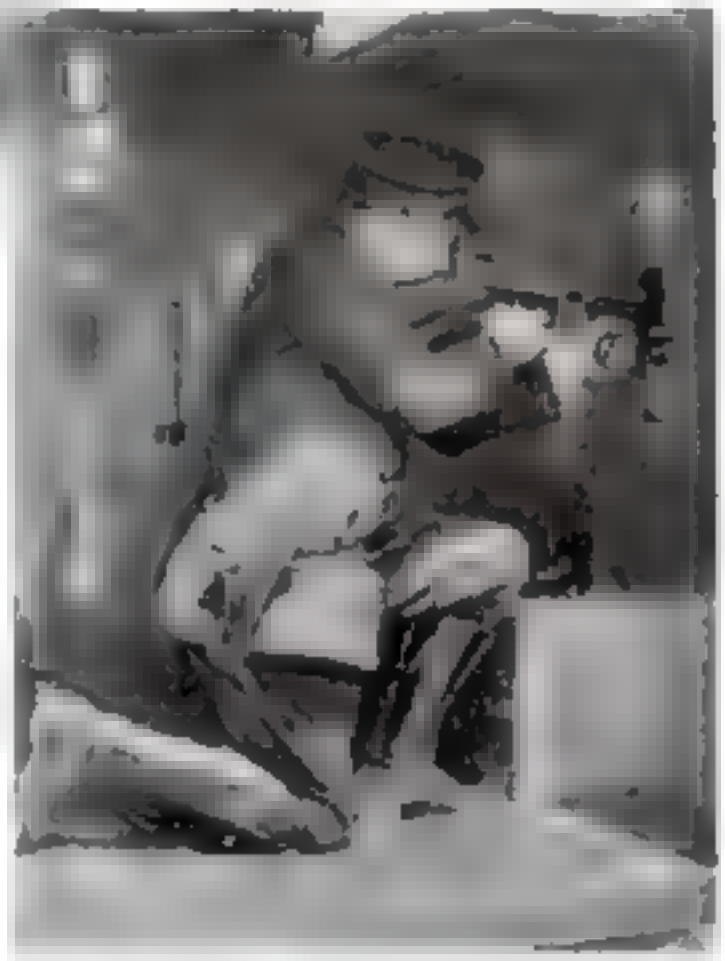
Forts on Wheels Defy Bandits

An Inside Story of the Cars Armored with Steel, Wool, and Glass That Carry Safely Huge Sums In Crime-Ridden Streets

By P. A. CARMICHAEL



How an armored car conductor, with guards delivers a million dollars in bonds



Peering through a bullet proof glass peephole of his armored car the express car guard can fire at bandits through one of the loopholes protected by steel shields

TRAVELING arsenals to be seen nowadays in the streets of many cities have dealt a hard blow to the holdup business. Not so long ago it was a regular thing to read of the robbery of bank messengers and payroll carriers; now criminals prefer to try holding up cashiers in their cages or cracking safes. Armor plate and bullet-proof glass have pretty effectually curbed the two-gun boys who used to ply their trade in the streets.

In scores of cities it is a common sight for one of these steel cars to roll up in front of a bank or other business house, deliver or load up with money bags, and dash away. The armored cars cost nearly $10,000 and haul money by the millions—actually by the ton. In New York a four day a business with the banks alone is from $5,000,000 to $10,000,000. Payrolls transferred amount frequently to $250,000 each. It is no uncommon thing to move a whole bank—twenty-five, fifty, or a hundred million dollars hauled through the streets!

The latest armored cars are fabricated of double layers of steel, with a stuffing of laminated wool between to stop, or at least slow up, any bullet that might pierce the outer layer. They are spotted in the sides and back with loopholes, covered with steel disks and provided with bullet-proof glass peepers. When a marksman inside puts the muzzle of his automatic pistol, shotgun, or machine gun to one of these loopholes, the disk automatically drops far enough aside to let the barrel through. When he withdraws the gun, the disk slips back into place.

SINCE the men in the car must keep a sharp lookout, a clerestory, or elevation of the roof, is provided to give room for windows. I examined a sample of their bullet-proof glass which had been used for pistol practice. Two shots from a .45-caliber pistol, fired from a distance of fifteen feet—the approximate distance it takes a bullet to reach maximum velocity—hitting virtually the same spot, had simply bounced off, leaving only two frosty smears where they had ruffed the surface and a few jagged cracks.

The glass, an inch thick, is fashioned in accordance with an interesting principle. The human body, especially the stomach, offers a peculiar resistance to bullets. The resilience, or "give," like that of a cushion, breaks the velocity of the bullet and so reduces its power to penetrate. The glass is in three layers—thin ones for the surfaces and a thick and comparatively soft one between. When a shot hits a surface, the middle layer "gives" and the bullet drops to the ground, though it may crack the surface glass.

The windshield, too, is made of this glass. Some of the cars use approximately $300 worth of it.

Thwarted at one point, your modern bandit may turn to another. If he cannot shoot his way to the money, he may try poison gas. But the armored cars of the U. S. Trucking Corporation, of New York, as well as many others, are equipped with gas ventilators to clear them of fumes.

A TYPICAL car is manned by a uniformed crew of four—the driver, in a separate, inclosed compartment, from which he does not emerge during the trip; the conductor, who carries the money or other valuables; and two guards. Each man has an automatic pistol and in the car one or more sawed-off shotguns loaded with buckshot, and a machine gun—or two—that rains out steel or buckshot at twenty-one discharges a second.

The sawed-off shotguns can be held up and fired like a pistol. You can't buy one of these fellows. They are sold only to police departments and to others who combat crime.

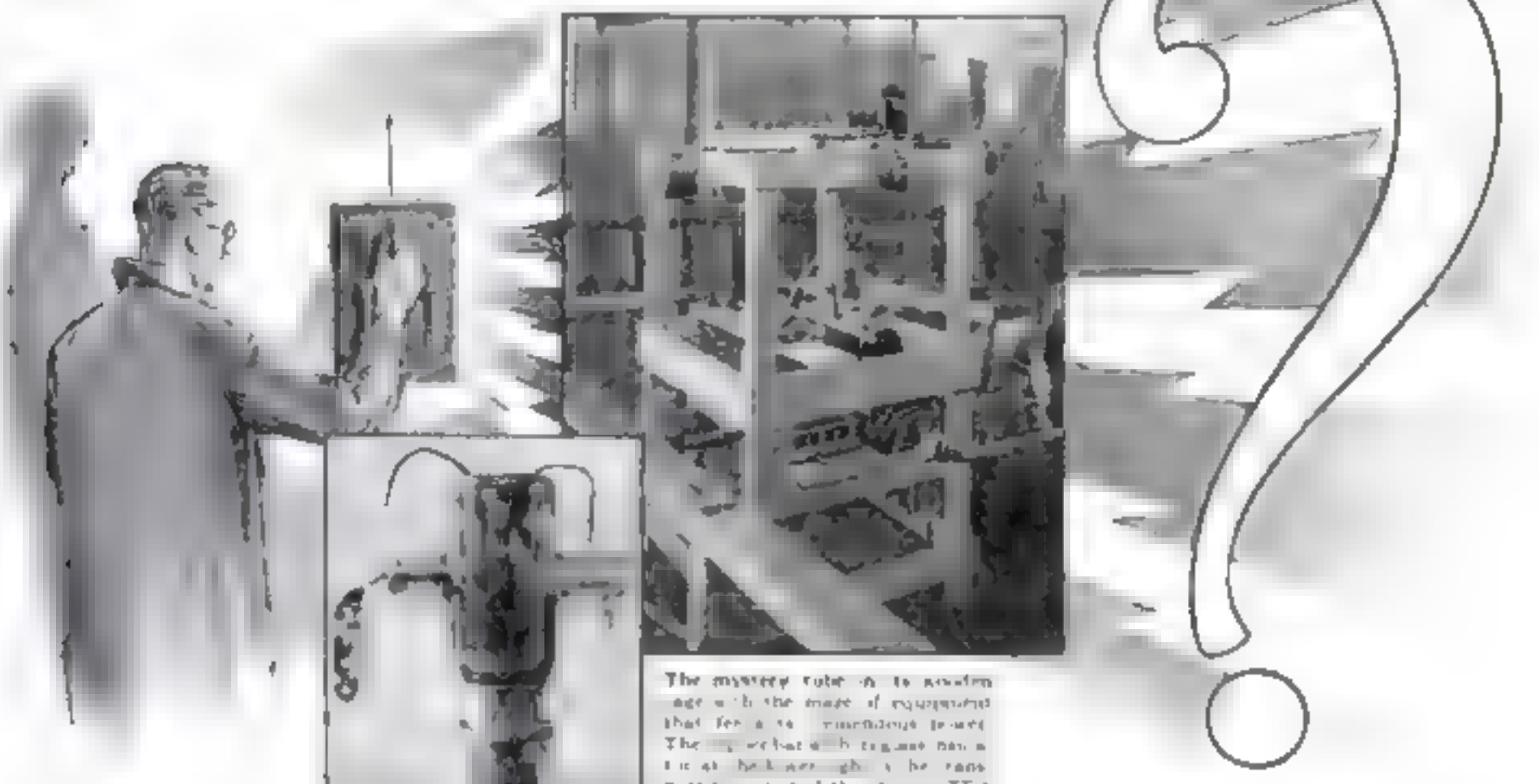
On reaching the destination, the conductor throws on a special emergency brake, which locks the wheels. It is designed primarily for use in case the driver should be shot while the car is in motion. One guard, his hand on his automatic, gets out. Then comes the conductor, carrying the money. After him strides the other guard. All are ready to shoot on the instant. Inside the car the driver is likewise ready to shoot through loopholes. So the delivery is made.

Despite the seeming invulnerability of steel to bullets, instances of armored car holdups are not lacking. In Pittsburgh a car was dynamited by thugs, who escaped with a payroll of approximately $100,000. On a main street of Buffalo bandits got "the drop" on such a car, killed two of the crew and got away with $93,000.

An express company which moves many millions of dollars a day offers its men $1,000 for any bandit they kill.

Not the least sufferer at the hands of the holdup men has been the U. S. Government. It is not so long ago marines were guarding railway mail cars and post office trucks. Now the Post Office Department has (Continued on page 128)

Giant Mystery *Tube* Promises New Radio Marvels



The mystery tube at its antenna cage with the maze of equipment that feeds it its [illegible] The [illegible] that engineers [illegible] the rays emitting aerial of the strange ZT-6

The fifty-million-waves-a-second radio tube that warms the blood of anyone standing near it and may prove of incalculable value to medical science as well as to industrial world

It Generates Strange Rays That Kill Animals and Cook Food and May Reveal the Secret of Wireless Power

By ROBERT E. MARTIN

INSIDE the enmeshing black wire grating of a short-wave radio research laboratory, engineers of the General Electric Company, at Schenectady, N. Y., have just turned loose the most wonderful radio tube in the world—the mystery "ZT-6." And while experts are still trying to account for the startling events that occur when its short waves run wild, engineers under the direction of Dr. W. R. Whitney are launching a new investigation with longer radio waves that promises fresh wonders.

Electric lamps glow without sockets or wires when near the mystery tube. Meters in rooms all over the building run wild. Approach the glass flask when its current is on, and you will feel yourself being baked from the inside out. Apples and sausages, placed on a copper rod "antenna" which is a duplicate of the tube's transmitting aerial ten feet away, are cooked to a turn in a few seconds! Sparks appear out of thin air to crackle about the wire netting that incloses the laboratory; and the engineers stand on wooden platforms because there is metal in the reinforced concrete floor. A metal bar lying on the floor blisters the hand that picks it up, though the bar is cold.

NO ONE could foresee what would happen when an engineer pulled the switch that set the five-inch-thick, two-foot-high ZT-6 tube glowing in its wooden cage at the south side of the laboratory. That was what Dr. Whitney wanted to find out. Weak radio waves, when their length is short compared with the quarter-mile waves that broadcasting stations use, are known to perform feats that seem magical to the layman. Only last year Dr. Philips Thomas, research engineer of the Westinghouse Company, lighted lamps by radio to demonstrate the possibility of radio power transmission—he used extremely short waves produced by a "mouse-power" tube of a mere thirty watts power. But Dr. Whitney strove to create, and try out, a tube that would loose short waves of enormous power simply to see what they would do. His new ZT-6 tube is a titan that hurls into the ether *fifteen thousand* watts of power—probably fifty times as much as has ever jarred a laboratory on as short a wave as it generates, and enough to kill rats placed in a cage near the mystery tube.

Even now that it has been tested, its possibilities are still unknown. Will it prove the long-sought key to radio power transmission? Does there lie hidden within it the principle on which may be based some future terrible "death ray?" Dr. Whitney, director of the research laboratory in which the tube was developed, warns against such sensational conclusions at this time. "No one can safely predict or promise a utility for such new things," he says. "It is clear that further experiments must first be carried out." Only one prediction he is willing to make—the surprising fact that medicine may have a new tool in the ZT-6 tube.

PERSONS approaching the tube have felt a warm glow not unlike that produced by an alcoholic stimulant—and, if they remained too close, pain in their limbs and joints. With a doctor present, several laboratory workers volunteered to stand in front of the tube for tests of its effects on them. In fifteen minutes' time, the physician had observed what were probably the first cases on record of artificial "electric fever." The subjects' blood temperatures had risen to nearly 100 degrees before the tube was shut off. "Fevers are sometimes artificially produced to start convalescence," Dr. Whitney points out, "and it may be

assumed that if we had here a perfectly harmless method for warming the blood it might have value."

Fruit flies, and also rats, were placed before the tube in an effort to learn more about the strange radiations. When a cage of rats was placed near the antenna that hurled the tube's waves into the air, the rats became excessively animated. Exposed longer, they died

Engineers set about finding why the mysterious waves warmed the blood. They placed vessels of salt water near the antenna, and found that when the solutions were of similar consistency to human blood with about one teaspoonful of salt to a pint of water—they, too, grew hot under the radio bombardment. Salt water would do, then, as a substitute for blood in the unique tests of the new tube.

When a metal-tip pole touched the ZT-6's aerial this two foot flame burned until blown out

SHOW your friend, who thinks science is only a cold-blooded thing dealing with mathematical formulas, this story.

Everything was ready. The tube was connected. The engineer stood with his hand on the switch. "And," says Mr. Martin, "nobody knew what would happen when the switch clicked!"

Not even the men who constructed the tube could prophesy the weird, unbelievable things that followed.

Nothing cut-and-dried about that. It was a moment of adventure as thrilling as the one in which Columbus sailed into unknown seas or Balboa looked over a mountain rim and saw the blue Pacific.

The tests disclosed that, at the extremely short wave length of six meters—a wave no longer than the laboratory itself—the salt water reached its greatest heat.

AT THE particular wave length of six meters, the human blood becomes a veritable electric network teeming with stray currents. For the comfort and safety of the experimenters, therefore, the tube has been readjusted to produce a longer, and hence harmless, wave. All the weird phenomena have not yet been photographed for scientific record. Some of the most spectacular ones, though, have been recorded

Picture a dazzling, sputtering plume of greenish-white electric flame, hurling molten copper in all directions, until it is blown out! When the experimenters touch a metal-tipped pole to the copper transmitting aerial—or even to the receiving rod, connected only invisibly by radio, to the glowing tube ten feet away—this electric flame, more than two feet high at the transmitting end, shoots into the air! They take the pole away. The mysterious flame remains, sputtering as it melts the copper bar. It resembles the "ball of fire" reputed to accompany tropical thunderstorms. By skillful manipulation they raise three or four such flames on a single rod. Some are higher than others, and their heights make a spectacular graph of the voltage or electrical pressure at points along the rod!

Not an electrical instrument in the entire building that houses the short-wave laboratory can be used while the ZT-6 tube is in operation. Through walls and ceilings, delicate measuring instruments feel the tube's force. Their dial needles quiver and run wild, just as the compass plays strange pranks during a brilliant display of northern lights. The story is told of a man who came into the laboratory with a wave meter, a delicate radio instrument. Suddenly the wave meter he was holding became red-hot and blew up!

When a sausage, placed in a glass tube, is hung from the copper bar that serves as a receiving aerial, it immediately begins to steam. A few seconds later, it is beautifully cooked by the stray electric currents that have coursed through it. An apple impaled on the rod is speedily baked. Cookies are baked in other tests with slightly altered apparatus.

THE wonder room where these things happen is a bare-looking screened laboratory, inside its sliding door wooden tables stand piled with electrical apparatus, while wooden gratings bridge the concrete floor between them. The tube rests in its framework cage, surrounded by an intricate-looking maze of wires, condensers, and oscillators that feed it its titanic power. Beside it hangs the ten-foot, horizontal piece of copper tubing that projects its mysterious "rays" straight through the air, to be picked up by another ten-foot rod four or five paces away, mounted upon a table. This is the rod on which the experimenters cook sausages and fry eggs.

Not very different in appearance from the ordinary high-power vacuum tube that radio broadcasting stations use is the new ZT-6, or high-frequency tube as it is called because of its fifty-million-wave-a-second speed. Its ability to pack its whole fifteen kilowatts of power—enough to light brilliantly half a dozen dwellings and run their toasters and vacuum cleaners as well—at the short wave length of six meters is the real secret of its astounding effects.

Picking radio power out of the air to light a high-power electric lamp with the aid of the mysterious ZT-6 tube which also can bake apples and sausage and even fry eggs in a few seconds. R. D. McArthur, right, holds a receiving antenna while his assistant holds another of the same type. When the antennae pick the high frequency waves pass through the body of the assistant and light the 250-watt incandescent bulb. The cage of the mystery tube is at the rear left and the horizontal transmitting antenna of the only half understood marvel is at the rear

Powdered Coal Runs a Ship

The *Mercer*

EVERY power-plant chief on the new coal boat Bituminous envies the engineers of the freighter Mercer, first ocean ship to burn coal dust as fine as face powder, hence a new epoch in marine engineering is predicted by Capt. J. Jefferson of the U. S. Shipping Board. These tests will completely refute that age-old gripe of seamen, coal dust in the food, for the Mercer's fuel is powder through and through. Not a particle of coal dust can get into the food because the Bituminous burns within the Mercer pulverizes and burns her own coal, delivering to the furnaces two separate streams of hot air, one mixed with finely crushed bituminous coal blown by steam engines, drops into hoppers and reduced to dust by pulverizers not more than a ton of raw coal lies on the coal-handling floor. Now a primary jet of hot air lifts the powder through a pipe and it is burned in the fire-box combustion is assisted by a secondary blast of hot air that mixes with the incoming fuel.

Harvest of the Laboratories

Microscope Movie Camera Films Bacteria in Action Effects of Sun Spots on Atmosphere Proved Audible Sounds of Nerve Impulses Can Be Radioed Erysipelas Antitoxin Found

Following the discovery that cornstalk pulp can be utilized in the manufacture of at least 300 articles, including paper and artificial silk, Dr Bela Dorner, Hungarian chemist has devised a machine for refining the pulp. Officials of a firm making the pulp at Danville, Ill., are seen examining the finished product

Examining refined cornstalk pulp drying on the huge cylinder of one of Dorner's machines in the first plant to make cornstalk products

NEWEST discoveries and inventions in the varied fields of science that are of special importance because of their bearing on our everyday life, and the present and projected researches looking toward further scientific advances and human benefits, are chronicled for you from month to month in these pages.

Watching a Star Explode

ONE of the rare spectacles of the heavens—the explosion of a star—is being observed through the Harvard College Observatory telescope at Bloemfontein, South Africa. The star, called Nova Pictoris, was until three years ago invisible to the naked eye. Suddenly it flared to ten thousand times its former brightness. Around its edge appeared a ring of cloudy matter evidently shot out by the blast. This cloud has steadily grown larger. Now, astronomers say, the star is doomed to fade and die

This mighty celestial event has added interest to the study of what the stars, including our sun, are made of. The generally accepted theory has been that they are masses of flaming gases. But now one of the world's foremost astronomers, Professor J. H Jeans, advances the surprising theory that they have liquid centers, surrounded by gas. He argues that if the sun and other stars were entirely of gas, they would collapse. Moreover, there exist double stars, undoubtedly created by the breaking apart of single stars. Gas could not so split apart. Liquid could

Recent research has given a clearer idea of the energy sent out by the sun. Imagine a globe with a radius of 93,000,000 miles, the distance from the earth to the sun. If the sun's energy were put to mechanical work, it could supply one horsepower to every square yard over the surface of such a globe.

For all that, it will take at least 15,000,000,000,000 years for the sun to burn out, says Dr. C. G. Abbot, astrophysicist and secretary of the Smithsonian Institution

Nerve Impulses Heard in Tests

RECENT discoveries have revealed human life as a wonderful electric power plant and system of transmission lines.

Two experimenters in psychology at the University of Iowa, Lee E. Travis and Theodore Hunter, say they have listened to messages flashed over the network of nerves in the human body, translating the impulses of nerve currents into sound waves that human ears can hear. Electrodes attached to the body detect the impulses. Magnified 800 times by a powerful amplifier, these nerve messages, we are told, can be broadcast by radio!

Dr. Ralph Waldo Gerard, assistant professor of physiology in the University of Chicago, has completed tests which indicate that the origin of nerve impulses, and of thinking itself, is a heat-producing chemical process—just as the source of electric currents over power wires lies in the boilers of the generating plant This discovery has been called "an achievement in the field of nerve physiology comparable to those of Prof. Albert A. Michelson in physics."

Dr Carl Voegtlin and Dr Floyd De Eds of the U S. Public Health Service have perfected a radio vacuum tube instrument which detects and measures electric changes inside single living cells. They have found, for example, that when a living muscle cell contracts, its electric voltage decreases; when it relaxes, the voltage increases.

First Welded Steel Bridge

NEWEST of engineering marvels is the first steel railway bridge to be built without a rivet or a bolt, opened at Chicopee Falls, near Springfield, Mass., on the Boston and Maine Railroad. The span was constructed entirely by arc welding, with a saving of one third in steel. The parts could be made smaller and lighter because they were not weakened by rivet and bolt holes. Moreover, much time and expense were saved. The completion of the bridge marks a step away from the noisy riveting gun.

On a "human treadmill" at Harvard University, Prof. L. J. Henderson and Dr Dill test an athlete's lungs while running and walking to learn new facts about fatigue. His oxygen demands are found by measuring the carbon dioxide in his exhaled breath

New Vitamin Discovered In Experiments on Rats

A SIXTH vitamin has just been added to that growing list of mysterious food elements without which, experts have found, men and animals cannot attain normal, healthy growth. The discovery, made by Herbert M. Evans of the University of California, and called vitamin F, is found in lettuce and liver.

Doctor Evans gave rats chemically pure foods containing all the five previously known vitamins, A, B, C, D, and E. Still the rats failed to reach half normal size. Natural foods had to be given to bring normal growth. Lettuce and liver proved most effective, indicating that these foods contained vitamin F.

Dr. W. F. Gericke, University of California, may revolutionize horticulture by his growing of plants simply in water treated with the food they require. The co-ed holds growing roots

Medicine's Great Advances

THE other day anatomists from Johns Hopkins Medical School went to Cape Hatteras on the most remarkable whaling expedition in history. Their object was to find a way to prevent caisson disease, or "bends," the dread malady which attacks deep-sea divers. By studying the anatomy of whales and porpoises, whose organs and tissues closely correspond to those of man, they hope to learn how these mammals manage to keep alive and healthy at great depths, and then to apply the secret to the safeguarding of divers.

An advance in medicine which "promises to rank in importance with insulin" was announced recently by five of the faculty of Northwestern University Medical school, who reported they had learned Nature's method of emptying the gall bladder—a discovery which may be used to cure gallstones and similar ailments. The secret lies in a secretion in the intestines lack of which produces gallstones. They believe they can extract the secretion and use it as a remedy by injecting it into patients.

Erysipelas is another baffling disease that soon may be vanquished. After four years' research Dr. Konrad E. Birkhaug, of the University of Rochester School of Medicine, has developed an antitoxin which, he says, has proved as effective in the early stages of the disease as has the antitoxin for diphtheria.

An important gain in the fight on cancer is the discovery, at the McGill Pathological Institute and Royal Victoria Hospital, Montreal, that nerves are present in human cancer. This fact, heretofore denied, indicates that cancer is not an independent growth of cells, and that there is a possible connection of cancer with the nervous system.

Living Bacteria Filmed By Micro-Movie Camera

THE newest wonder of motion pictures is that of showing the invisible world on the screen.

A microscope movie camera now is employed by Heinz Rosenberger, of the Rockefeller Institute of Medical Research, New York, to reveal the remarkable form of perpetual motion which begins when clay or other fine powder is suspended in water. The tiny particles are seen to dart and whirl ceaselessly. This motion, called the Brownian movement, is believed to be caused by continual bombardment of the particles by molecules of the liquid in which they are suspended.

Microscopic bacteria, too, are filmed in action. Dr S. Hayne-Jones, of the University of Rochester Medical School, "shoots" countless invisible creatures that war on mankind, spoil food, and attack our bodies. He produces a feature film which in a few minutes depicts their private lives, from birth to death.

The same sort of ingenuity which has brought the motion picture drama to the stage of perfection described in POPULAR SCIENCE MONTHLY's current novel, *The Movie Maker*, thus is being applied to unfold the drama of the unseen world.

Dr. Ward E. Kuentzel, of the U. S. Department of Agriculture, has materially reduced the cost of making hydrogen gas by devising a simpler way of taking the deadly carbon monoxide out of it

Lightning Bolt Put to Work

"GREAT, but what use is it?" was the question asked recently when 3,000,000 volts of electricity, stored in artificial "clouds" in the General Electric Company laboratory at Pittsfield, Mass., were let loose in a tremendous man-made lightning bolt.

An answer, illustrated by this photograph, came a few days later. In Philadelphia, engineers of the same company sent million-volt lightning bolts, jumping and sputtering in irregular arcs eighteen feet long, to test the efficiency of huge oil circuit breakers, designed to safeguard power transmission lines. The flashes played about the circuit breakers, exposing them to much the same conditions encountered in a lightning storm.

A spectacle of the laboratory thus proved its practical value by revealing the possible defects which might cause severe loss.

Sun Spots Affect Radio

THE sun's present attack of "spotted fever," believed to influence vitally weather, health, crops, and other earthly interests, is lasting longer than usual, experts say. Sun spot outbreaks come in cycles, eleven years apart. Usually they continue only a few months. This time, however, they are lasting many months.

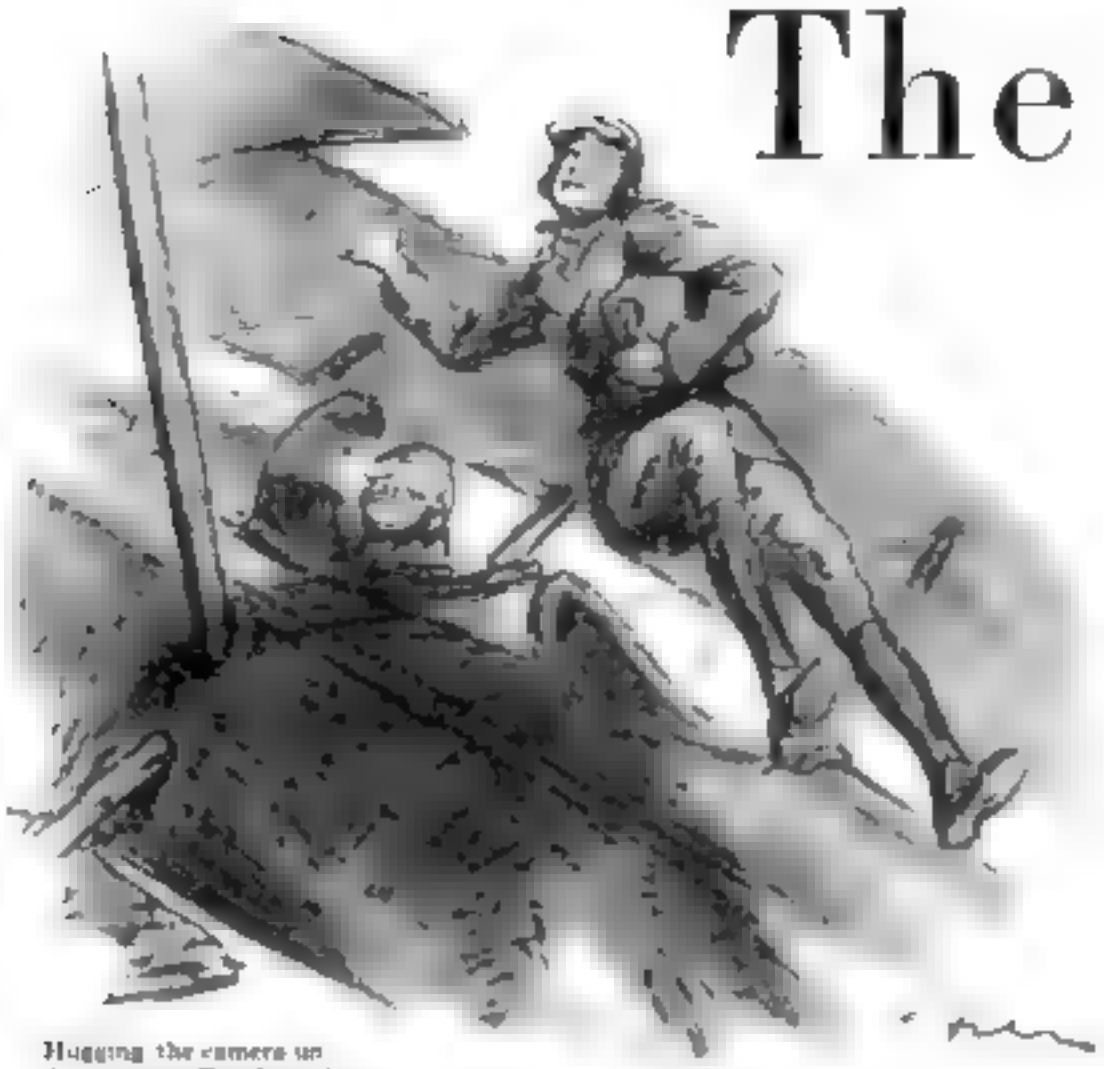
At the Harvard Astronomical Laboratory at Cambridge, Mass., observers photograph the sun daily to record the number and size of its spots. At the same time they measure variations in the intensity of radio signals from Chicago. These records have established a direct relationship between the spots and disturbances in the earth's atmosphere. Dr. Harlan T. Stetson, in charge of the observations, says the method may be developed for use in weather forecasting.

The Movie Maker

Adventures of An Inventor On the "Lot"

By S. W. NEWMEYER

Illustrated by ERNEST FUHR



Hugging the camera in the one arm, Don leaped

The appeal of the screen lies in its powerful realism, achieved by the magic of invention. Latest of marvels is the talking picture, recently carried to high perfection by engineers of the Bell Laboratories, by translating sounds into light and so recording them on the film for reproduction. In The Movie Maker the delightful people of the story lead you back-stage and reveal many other discoveries which have brought the world of make-believe to life. —The Editor.

THE attempt of Don Kennedy, young movie director, to produce a big feature picture of his own was a series of thrilling adventures, in which he managed, by ingenuity and almost reckless courage, to keep just one lap ahead of disaster. Standing with him through thick and thin was a group of faithful friends—Judy Burke, a script girl and scenario writer; Jerry, her brother, a stunt flyer; Margaret Moreland, a once famous but fading screen star, and Professor Mahrlenburg, an aged photographer. When the "shoe-string" venture was almost on the rocks, they barely escaped failure by winning the financial backing of Silas Rogers, wealthy newspaper owner, in return for giving his spoiled daughter, Mabel, a leading rôle in the picture. Don's chief asset was a money-saving invention of his own, a process for superimposing studio action upon scenic backgrounds filmed abroad. Thus, while his little company worked on the "lot," he sent "Bozo," an expert photographer, to Europe and Asia to shoot the backgrounds. Once more disaster seemed when word came that Bozo had been kidnaped by an Arab chieftain, Sheik Ali Rachil, who demanded a million francs and a photograph as ransom. Now read on.

BEFORE the train had rolled to a stop in the Los Angeles station, Don caught sight of Professor Mahrlenburg eagerly scanning the cars. As he jumped off, almost at the professor's side, the old man waved a sheet of paper at him and shouted:

"They've come—Bozo's reels!"

"What!" Don exclaimed.

"Read this." The professor thrust the letter into his hand. "It came with the films."

It was an urgent note from Bozo—characteristic, yet strangely complimentary to his captors.

"'Greatest fellows on earth. Treat me fine.'" Don skimmed the letter rapidly, jerking out the sentences to his audience. "'Ben Nadir, one of them, a prince of a fellow, did a lot for the French in the World War. He knows trench English, so he told me all about it.'"

"Evidently Ben reads English, too," murmured Jerry. "That's why Bozo's not expressing his real feelings."

Don continued reading aloud:

"'Told 'em they captured the wrong camera man. My company dirt poor. They can't hardly understand that because this is the same bunch that captured some of Carleton's stuff. But they got a lot more than costumes. They got some acetilin tanks and drug 'em all the way up the mountains with other junk because they thought they were torpedos. So I rigged up my projection outfit and run off a show for them. Screen was a big rock on the side of a mountain but not so bad. And now this bunch is crazy to have their own movie theater here in the mountains. So I been dickerin' with 'em and they'll knock off the million francs if you send a big projection machine and a dozen reels. Get mostly news reels or army stuff, plenty of action and battleships. And send them quick to Ben Nadir, American Express, Morocco. Better shoot a cable to him same address soon as you get this saying stuff is on the way. And don't try any funny biz like sending the marines to do the well-known rescuing act, or they'll toss my carcass over the edge of a mountain. And don't forget the phonograph and records. They got to have music with their pictures.'"

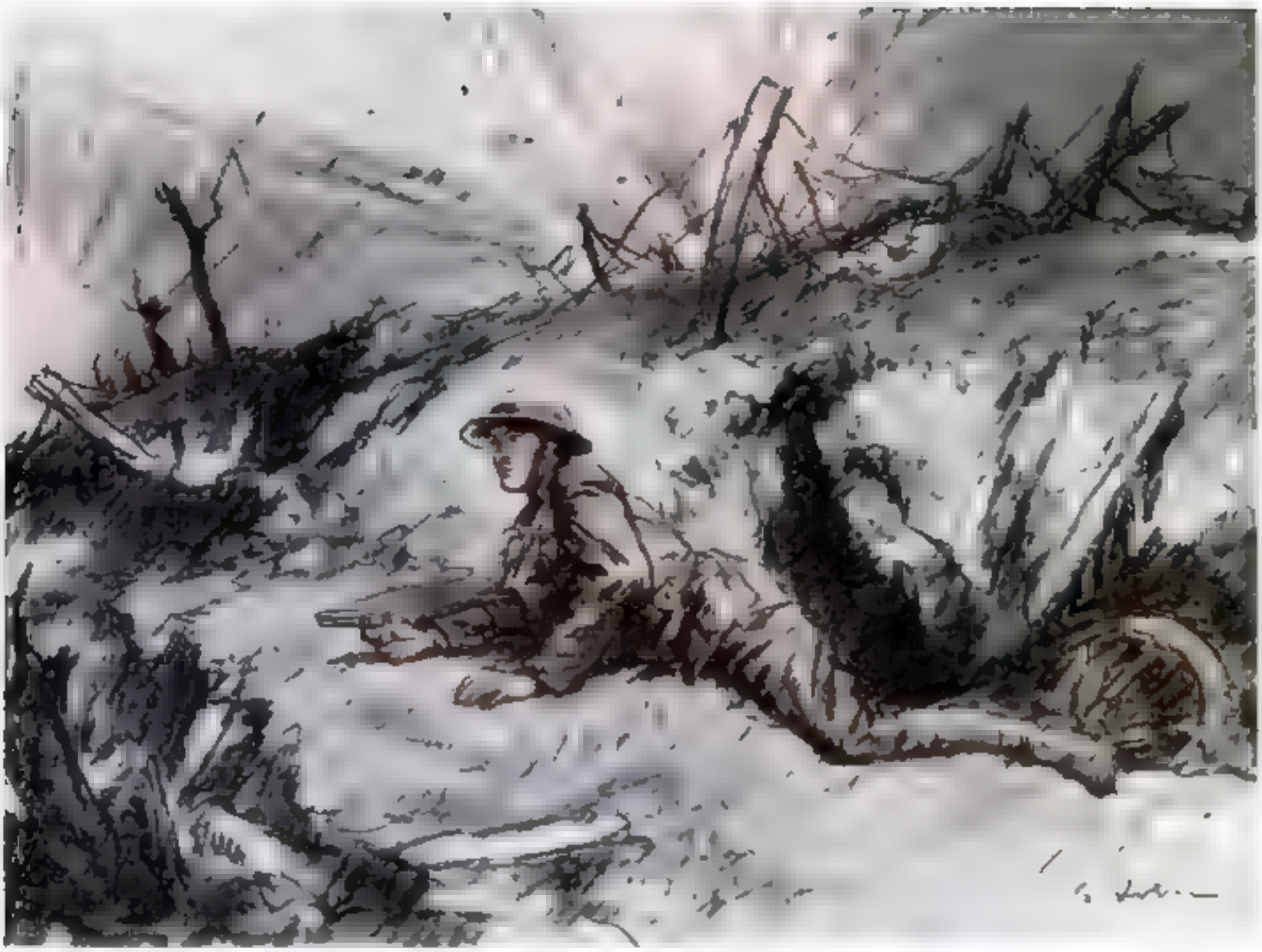
Bozo's instructions were followed to the letter, and no amount of digging on the part of Silas Roger's staff of reporters could pry out of the group any information concerning Bozo. It was not alone his star camera man Don was considering; he also wanted to reserve such good publicity until he was ready to release it for the big picture.

THE evening of their return from Montana was given to a long-drawn conference, with Judy, Don and the professor wrestling nightly over the scenario and technical scheme of the play, shifting and rearranging action and location to suit the changed conditions. They could count on receiving no more background reels from Bozo in time to use for the completion of the picture, though they were jubilant that his Arabian films would save them the trip to the Mohave Desert.

"If we could only get these shots," mourned Judy, spreading out a sheaf of photographs and reproductions of paintings of scenes in the Holy Land—the Damascus Gate, the Church of the Holy Sepulchre, and views of ancient landmarks and time-worn roads.

"Too expensive to build for such short sequences," Don remarked, "unless the professor could fake most of them with the painted glass screens."

"Not for the long shots," responded the professor, "and you



Over the strip of no man's land, with its tangle of barbed wire and yawning shell holes, Jerry crawled from hole to hole

want them for the march of the crusaders' army, don't you?"

"Most of them," Judy replied. "Part are for the siege of Jerusalem."

The professor took out his pocket magnifying glass and squinted carefully at the photographs.

"I can give you almost as good background negatives of these scenes as Bozo himself might," he announced, a gleam of triumph in his eyes. "I will take motion pictures of the still photographs—and you can use them just like Bozo's background negatives!"

* * *

HUNDREDS of crusaders encamped along the River Jordan, rugged, weary Knights of the Cross, building their camp fires. And standing on the side of a hill where he could overlook the fires dotting one side of the curving river, a young man with a megaphone shouted commands, while three camera men stationed at vantage points cranked their machines steadily.

But only on the screen would the river make its appearance as the Jordan. It was the Los Angeles, that river of many aliases, now fairly sizable with early winter rains. The sun was bright and high overhead, the day clear and golden, and at the young director's elbow a stocky man with a straw-colored mustache beamed over the scene with a proprietary air. Since viewing the projection room rushes of his daughter's close-ups with a satisfaction he could not conceal, Mr. Rogers was disposed to be more amiable.

"Tell you what, Kennedy," he said abruptly. "I'll raise my offer to a hundred thousand for half interest in your thingumbob machine. Been thinking some of getting into the game myself—make you head of the producing end if I do—"

But he was interrupted by a shrill double whistle at his side as Don gave the signal to stop action and cameras. And while the assistant directors herded the extra people together, the two men walked down the hill, Don apparently listening to Mr. Rogers' half-formed but full-blown plans for a new motion picture company. In reality, though, he was engaged in an inner conflict—as success beckoned round the corner, the necessity for immediate money was becoming daily more grim. He had finally drawn from Margaret the fact that unless she could pay a twenty-thousand-dollar note by the first of January, everything she had would be swept away. He needed, also, an additional thirty thousand or more to exploit the big picture, for he had decided, rather than hawk it around from one exhibitors' group to another, that he himself would put it on Broadway, if it were at all possible to raise the money. And here at his elbow Mr. Rogers dangled a tempting hundred thousand. But at what a price! In the big picture they were making, his background machine had already demonstrated its ability to save hundreds of thousands of dollars, with the assurance of an increasing harvest as the years passed. Yet it was not reluctance to divide the profits with Mr. Rogers that made Don hesitate. It was his fear that in surrendering half control to the wily older man it might be only a short time before the original owner would be squeezed out. Hearing again the rising inflection in the voice at his elbow, Don turned and answered it decisively.

"No, Mr. Rogers, I won't sell a half interest to anyone, but I'll give you a quarter interest for fifty thousand dollars."

But Silas Rogers stood firm—a half interest or nothing. His manner indicated that he might even be persuaded to raise his bid a trifle, but only for control equal to Don's. On that they parted, regret expressed on both sides. Mr. Rogers, undefeated and willing to bide his time, hurried to his waiting car which had been parked beyond the range of the cameras.

DISMISSING momentarily the unsolved financial problem, Don turned briskly to the business at hand. He was determined to get all the crusade mob scenes that day, so after the lunch wagons had fed the hungry hundreds scattered at ease on the hillside, he and his assistants marshaled them all into line, eight abreast. Then, along an infrequently traveled stretch of narrow rough road, they marched toward Los Angeles, the sun glinting on helmets, shields, and lances. Ahead of them traveled a slow stream of trucks and busses. A heavy moving van rumbled along at the tail of the vehicles, the cameras clamped on to its rear end. One was focused to shoot the

There was a tremendous crash as the plane shot squarely between the two trees sheared its wings off, and dived into the cabin

advancing army from exactly center position, the lens being very slightly masked on both sides to cut down the angle of exposure so that it would include only the figures marching down the middle of the road. This shot would be combined in the laboratory with a background negative the professor had made from one of the still photographs of the approach to Jerusalem.

A second camera, clamped to the top of the van, tilted its lens to photograph the tops of the crusaders' heads. At the side of the roadway was the third camera, stationary, its tripod spread low to the ground. Its lens caught only the feet of the marching men, with an occasional queer angled upward shot for variety. These cameras were unmasked, since the position of their lenses prevented either from taking any appreciable amount of background.

NEXT day, with about thirty extras and the chief members of the cast, Don returned to the river for close-ups and foreground shots. In the studio he had previously prepared the shots to be combined with these, for it was to be a sequence showing the war-weary knights seated around their camp fires, dreaming of home. Rising above the flickering lights and shadows cast by the fires, their dreams were to take hazy form in scenes and loved ones left behind. This effect would be obtained merely by a double-printing operation, the actual picture of the camping crusaders to be printed strongly, the visions superimposed faintly, with ghostlike transparency. The latter were photographed through a silk diffusing lens screen which blocked out most of the background.

For good measure, because he was obliged to cut down on the Holy Land footage owing to Bozo's defection, Don had worked out another scene to take place in the big banquet hall of the English castle. The sequence involving the return of Jerry and his bride to the castle after their crusade to the Holy Land had long ago been taken, but Don decided to insert a banquet scene. To give the illusion of great size and distance, everything in the banquet hall had been built on a graduated scale, growing smaller and narrower as the scene stretched away from the camera. Don selected the banquet guests on the same plan. The taller men he seated at the end of the table in the foreground, the medium sized men next, while very short, slight men were placed at the extreme end of the table, the seating distance between them growing less and less down the queerly constructed table, which was large and square at the foreground end but narrowed considerably at the other.

"Honestly, Don, this looks absurd to me," protested Jerry from his seat at the head of the table. "It's so obvious to anyone with eyes that we're just a collection of talls and shorts going into a huddle at one end."

"That's because you're right in the picture and are looking at it with both eyes," retorted Don. "Get several yards away, squint at it through this reducing glass with one eye, and then tell me what you see."

Obviously unconvinced, Jerry stalked some distance away and squinted, frowning.

"Well?"

"It does look pretty good," Jerry admitted reluctantly, "but I'm still able to see that you're just faking that effect of size and distance."

"THAT'S partly because you know it's faked and your mind is subconsciously correcting the illusion, and partly because you can see beyond and around the set, where things are not arranged to continue the illusion. When the scene is shown on the screen it will include nothing that is not exactly according to scale and—"

"But the audience won't be squinting at it with only one eye!" Jerry resumed his seat and continued his argument while Tim measured the focus distance. "How about that?"

"The audience sees the picture on the screen as if through one eye because that is the only way a single-lensed camera can take the picture," Don explained. "That's why we can avoid flatness and get depth only by manipulating light and shadow effects. There's been a two-lensed camera invented on the principle of the old-fashioned stereoscope. (Continued on page 144)

$200,000,000 for Research; What Do We Get?

¶ For months two research workers in the Bell Telephone Laboratories in New York studied the electrical properties of quartz crystals. Their work was purely scientific. Yet out of it, a few weeks ago, came a small crystal of quartz which virtually has solved one of the most difficult problems of vision at a distance—that of synchronizing the transmitting and receiving apparatus to assure perfect images. In the following article Mr. Stockbridge tells of many other amazing ways in which research in pure science has been applied to the use of mankind.

By Frank Parker Stockbridge

Silken garments, leather slippers, velvet draperies, upholstery, paper book bindings—all are synthetic products of research laboratories

"WHAT good is science, anyway?" Invention is obvious. Everybody can see the use of a machine. But the chemist fiddling with solutions in test tubes, the physicist playing with electrons in a vacuum—they are dealing with mysteries that do not seem to have any practical application to human affairs. Maybe so. Let's see.

Last year business and industrial corporations in the United States spent $200,000,000 for scientific research in due different laboratories, according to Secretary Hoover and the National Research Council. Let's see what they got for their money. And what we, the consuming public, got out of it.

Well, better bread for one thing. A big company, with bakeries all over the United States, asked the Mellon Institute of Industrial Research of the University of Pittsburgh why its formula when used in Cleveland did not produce the same bread as when used elsewhere, and offered a bonus of $10,000 to the three research workers assigned to the problem.

They discovered that Lake Erie water lacked certain mineral salts. They added them. By adding more to any water, they found, the action of the yeast was so accelerated that half as much as the formula called for would raise the dough; there was a saving, moreover, of almost two percent in the amount of flour, sugar, and shortening needed to produce full-weight loaves. The salt compound was patented. It had cost the bakery, including the $10,000 bonus, not more than $25,000 for a saving of a million dollars a year. And now the patent has been sold to a yeast company for something like two millions.

That application of pure science has given the whole country better bread than we ever had before, and it has kept the cost down.

Scientists have made startling discoveries about the constitution of matter. The atom of every substance is made up of particles of positive and negative electricity, which are called protons and electrons. The atom is a minature solar system, with a proton nucleus like a sun and the electrons revolving about like planets. Amazing discoveries, but of what practical use?

Well, the scientists found that when a piece of metal is heated electrically in a vacuum it shoots off a stream of electrons, and another piece of metal for the electrons to bounce against will detect the waves set up by electrical discharges at a distance. That was the beginning of the audion tube which has made radio broadcasting possible. Its application in a slightly different form gave us long-distance telephony; experts value these discoveries at $20,000,000 a year in this application alone. To you and me it means that we can talk across the continent at a trifling cost without raising our voices.

Professor Irving Langmuir, of the University of Chicago, got leave of absence and in the research laboratory of a great electrical company he played with gases in vacuum tubes for a year. Then the company asked him to show its engineers what he had found out. The result was the modern gas-filled electric light bulb which gives more and better light at lower cost and lasts longer.

Is science practical?

Let's see what the chemists have discovered about wood.

The slang term "a wooden kimono" means a coffin, but women today literally wear wooden kimonos—wood pulp, which is cellulose, converted by chemical means into precisely the same substance into which the silkworm converts the mulberry leaves, and spun and woven into a perfect imitation of natural silk.

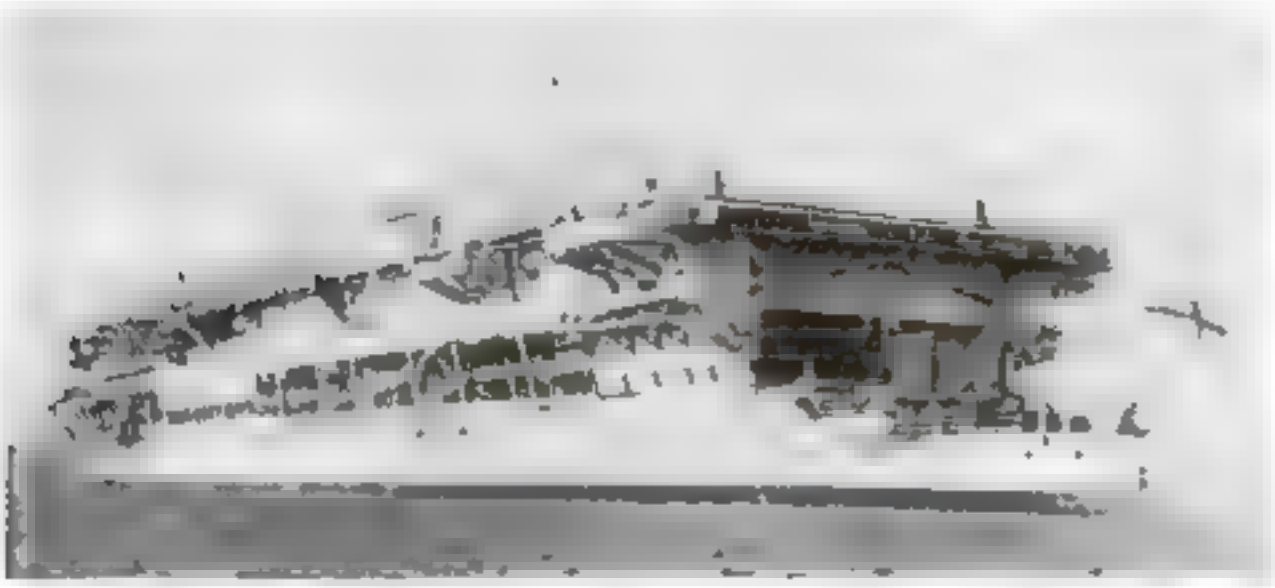
The artificial silk filaments, treated with certain chemicals, become artificial wool. One factory is already turning out a hundred thousand pounds a day; soon half the men in the world will be wearing wooden overcoats. And the fabric will cost not much more than a quarter as much as natural wool.

The new lacquer finishes, which are filling the streets with brilliantly colored motor cars, are made of cellulose. One coat, or two at the most, serves the same purpose (Continued on page 124)

Uncle Sam's candymaker, J. Hamilton, who uses chemistry to improve the nation's sweets

Aviation *Reaches New* Heights

Deadliest War Plane Can Climb Five Miles in Ten Minutes; Aircraft Carry Hospital Wards and Big Radio Laboratory; Americans Smash Endurance Record; Italian Sets World Speed Mark



Britain has her own idea of aircraft carriers, as this photograph of the converted battleship *Courageous* shows. It differs radically from the new American carrier *Lexington*, sister ship of the *Saratoga*, which was pictured on the cover and described in the May POPULAR SCIENCE MONTHLY, yet the British craft is one of the mightiest. A scene on the *Lexington* is shown on the adjoining page

Nations Share Air Triumphs

EUROPE shares honors with America for aviation exploits in 1927 and 1928, an analysis of recent great flights shows, though Americans were supreme in spanning the Atlantic and the Pacific.

Foremost among long-distance flights was that of the Italian airman De Pinedo, who twice spanned the Atlantic to cover 25,200 miles, going from Rome to the Americas and home again. Costes and Lebrix, French flyers, have done more than 25,000 miles on their round-the-world trip, reaching San Francisco from Paris. The American Dargue's tour of South America covered 20,500 miles, and a Dutch flyer, Koppen, took a 17,400-mile jaunt from Amsterdam to Batavia, Dutch East Indies, and back.

Among speed kings of the air who made long flights were the Frenchmen Pelletier d'Oisy and Gonin, who flew 6,750 miles through Egypt, Morocco, and back to Paris in six days. A Russian, Skestakoff, flew from Moscow to Tokio and return, 10,250 miles, in twelve days. Two Englishmen, Kingsford Smith and Ulm, took ten days to journey 8,075 miles around Australia by plane. And the Americans, Brock and Schlee, in their round-the-world flight, flew the 15,850 miles from Detroit eastward to Tokio and thence, omitting the Pacific hop, home in twenty-one days.

New Air Surveying Exploits

IMPORTANT advances in surveying by airplane are under way in England and America. The English have completed a new giant surveying plane with a cruising range of 600 miles to chart impassable regions in Africa. Landings at twenty-mile intervals hitherto have been required in surveying by airplane.

The American Army is ready for the first test, over 2,500 miles of territory along the Florida east coast, of a new four-lens airplane camera which will record landscape details from four angles.

Planes Rise Like Rockets

TINY planes that can dart upward at a steep slant, rocketlike, five miles in ten minutes, are the latest amazing war craft of the British Air Force. Known as "interceptor" planes, they are believed to be the most deadly weapons for short range attack in the world, so fast can they leap into the air to hurl themselves without warning upon huge enemy bombing planes or invading airship fleets from a favorable high fighting position that they can speedily attain.

Just great roaring engines, with tiny wasplike bodies and knife-edge wings—that much is known of the planes' construction, which is a closely guarded secret. So light in weight are the machines that search must be made for lightweight pilots, with unusually sensitive hands, to guide the tricky craft. They will hurl a rain of incendiary bullets from special lightweight machine guns, it is said, and when all other means of attack fail the pilot will deliberately collide at full speed with an enemy machine, trusting to save himself by parachute.

The plane crew, and four-lens camera for the Army's Florida aerial survey operations. Left to right: Private Irving Kalmeyer mechanic; Master Sergt. Andrew Matos, photographer; and Lieut. Julian Dexter, pilot

Radio Laboratory in Plane

AN "AIRPLANE full of radio sets" is the giant tri-motored Fokker plane that the Army Air Corps, at Wright Field, has just fitted up as an experimental flying laboratory. While it soars above the clouds, technical experts within its spacious cabin are able to take delicate measurements, change electric circuits, and make tests with all the convenience of a workshop on the ground. Such tests will aid the development of new, improved radio devices for airplanes, as well as other flying equipment, for try-outs made in actual flight have a practical value that no ground trials can equal.

In the cabin are two short-wave radio transmitters under test, a new code-message transmitter that works like a dial telephone, and standard radio-beacon sending and receiving sets that are installed just behind the pilot's cockpit. Three types of power supply—a wind-driven generator, a storage-battery-and-generator set powered from the left engine, and a new two-voltage generator hooked to the right engine—are being compared. In addition, the experts are testing various types of radio antennas for plane use and a capacity altimeter—a device that tells electrically, regardless of intervening fog, the height of a plane above the ground, thus warning pilots flying over mountainous regions of impending danger before it is too late.

Plane with 150-Foot Spread Has Wheels Bigger Than Man

LANDING wheels taller than a man, and a massive fuselage twelve feet deep at the cabin section, mark as phenomenal the new *Inflexible* of the British Air Force, probably the largest land plane in the world. With its 150-foot wing spread, it must be skillfully maneuvered sideways into even the largest hangars of the Air Force. Such a giant plane, it is foreseen, may prove a passenger-carrying competitor of future dirigibles.

When Squadron Leader J. Nakes and a daring mechanic recently took the monster on its trial flight, they carried parachutes to save themselves should it prove too unwieldy to control. But the flight was successful and the huge bird taxied to a graceful landing.

Balloon Dwarfs All Others

WHAT high altitudes do to motors and men, and what uncharted winds exist in the upper stories of the atmosphere, are questions Germany is investigating with the largest balloon in the world—the spherical 353,000-cubic-foot monster *Barlach von Siegfeld*, recently completed. Carrying four passengers and an experimental motor in the basket beneath its eighty-five-foot gas bag, it is making repeated ascensions miles high.

U. S. Retains Altitude Mark

LIEUT. CARLETON C. CHAMPION, U. S. Navy flyer, holds the official world's altitude record, according to the Federation Aeronautique Internationale, despite the Italian airman Renato Donato's recent reported feat of a 38,559-foot airplane ascent. Donati failed to exceed Champion's height by 100 meters (328 feet), the distance required to establish a new mark.

Champion's record, made in a flight that ended in a spectacular flaming descent, has been re-checked as 38,474 feet by the world-governing aeronautical body. Other aspirants' standings are:

Lieut. J. A. Macready, ex-U. S. Army Air Corps; second place, 37,509 feet. The U. S. Bureau of Standards reduced to this figure his originally reported world's mark of 38,704 feet.

Jean Callizo, former French record holder; disqualified by F. A. I. for fraud and records voided.

Capt. H. C. Gray, Army Air Corps, 42,470 feet in each of two balloon ascensions, of which the second cost him his life. Either would have been a world's record for all aircraft; but the F. A. I. disallowed the first because of a forced parachute drop and the second because he did not have "possession" of his instruments.

Here is the Supermarine-Napier racing seaplane S 5 in which Flight Lieutenant S. M. Kinkead, of England, met his death while trying to break the record of 297 miles an hour held by Major Mario Di Bernardi. It is shown being prepared for the effort. Di Bernardi since made a new 318 mile record.

[redacted] ambulances are in use between London and rural [redacted]. Here a patient on a stretcher is passed through a tunnel in the nose of a Vickers "Vimy" ambulance plane. The airplane's cabin is provided with [redacted] cots—being a miniature hospital ward

Two Records Shattered

AMERICA has regained the air endurance record with a 53 ½-hour flight and an Italian airman has shattered the world's speed record at the amazing pace of 318 miles an hour.

At Jacksonville Beach, Fla., Edward Stinson, veteran pilot, and George Haldeman, hero of the trans-Atlantic west-east with Ruth Elder, soared aloft in their single-motored monoplane, circling a distance estimated equal to a New York-Dublin trip and return. They broke the 51-hour record held by the Germans, Johann Rustea and Cornelius Edzard.

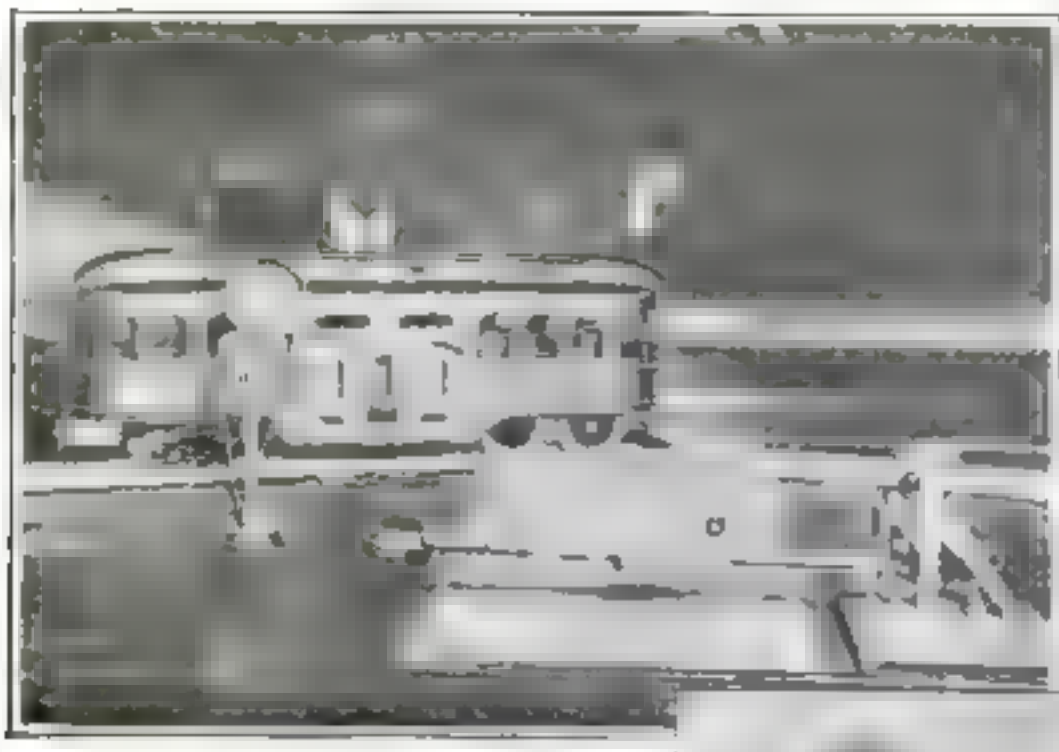
On the same day, Major Mario Di Bernardi, Italy's speed king, smashed his world's record at Venice, going 318 miles an hour. At one point he was clocked at 350 miles an hour, the highest officially recorded speed ever reached by a human being.

New "Gear-Shift" Propeller

WITH blades that can be set, even in full flight, to any desired angle, an amazing new type of propeller adapts an airplane for speed, for climbing, or for load-lifting at the will of the pilot. The variable pitch propeller, as the device is called, is said to be in effect a "gear-shift" for airplanes similar to the gear changes by which an automobile increases pulling power at the sacrifice of speed.

Hitherto, says W. R. Turnbull, Canadian inventor of the device, an airplane's use has been limited by the type of its propeller. Racing, for instance, requires a propeller with extremely tilted blades; load lifting, flattened blades; and altitude climbing, still another type. In Turnbull's invention, the propeller is adapted, through an electric motor at the pilot's control, to any of these uses. The plane could even fly backward; though Turnbull has decided to eliminate this feature lest too reckless stunt flyers try it.

Their wings folded back, the fighting brood of the *Lexington*, one of the U. S. Navy's new giant airplane carriers, wait the command that will send them flying. An idea of the huge size of this vessel is obtained when you consider that 88 planes similar to the few shown fit on her deck. She is 888 feet in length, the longest naval craft afloat. Her maximum speed is thirty-nine miles an hour



A car on a toy railroad demonstrates the new self-operating safety gate. Left: At the approach of a train an electric apparatus lowers the gate. Below: One end of a flexible line is held on shore. The line pays out from a cylinder which is dropped on the ship in the picture to a wrecked ship

Self-Acting Crossing Gate

WITH the aid of a model railway, toy size, a new self-operating crossing gate was recently demonstrated by the National Safety Council at Chicago. At the approach of a train an electric apparatus lowers the gate descend. In this way grade crossings throughout the country may be equipped and made safe for motorists. A unique feature of the new gates is the counterweights, so designed that the passage will be clear if a motorist in the act of accelerating his car fails to see the descending barrier in time to stop his car.

Planes Aid Wrecked Ships

CYLINDERS dropped by airplanes to wrecked ships will carry life lines to rescuers if the invention of Lieut. Commander Carl C. von Paulsen, demonstrated at the right, is installed on all coast guard aircraft, as it is already in some. Flying over the shore, the aviator drops the weighted line near the coast guardsmen, then he swoops out to the stranded ship. The line pays out of a cylinder which he drops on the ship. Experiments with the device have shown this to be a great improvement over the old method of firing a line out to the disabled ship with a cannon.

Pillow Cures Sleeplessness

VICTIMS of insomnia may now be lulled to sleep, it is said, by opening a small window in a newly invented pillow and inhaling evaporating liquid previously dropped on absorbent cotton inside. No anesthetic or narcotic is used, the inventors state, the liquid being a harmless vegetable oil.

Electricity's Strange Uses

FROM making ice cream out of cold-storage butter in the mountains of Virginia to electrocuting bugs in a peach orchard, the uses of electricity are widely varied, a recent survey discloses. Mushrooms thrive best right after storms, and so enterprising growers in Pennsylvania create electric thunderstorms in their mushroom cellars with electricity from the light socket. At the Government radio station at Arlington, Va., ice and

sleet are melted from the antenna by electric currents. The enormous coast defense guns at Sandy Hook, N. J., are raised, fired, and lowered by the same kind of electricity that is used to sort white potatoes in Maryland. While many beauty parlors remove superfluous hair with electricity, some Latin American barber shops claim a method of using the current to grow hair on bald heads.

Alaska, America's Bargain, Yields Over a Billion Profit

ALASKA, cold and barren, was sold to the United States in 1867 for $7,200,000, one of the largest real estate transactions ever completed. Russia, perhaps, was glad to get rid of such a tremendous "white elephant," and no doubt many thought that the United States was throwing its money away, yet since that time, reports reveal, Alaska has produced more than $500,000,000 worth of fish alone. With furs, copper, gold, platinum, and other precious products, the "barren" territory has yielded more than $1,133,000,000 over the original investment, it is estimated.

Lost Sheen of Silk Restored

SILK, mercerized cotton, and artificial fiber may be restored to their original gloss, lost by washing, by a new chemical preparation perfected in Berlin, according to reports. The new fluid is said also to disinfect the cloth

Peril in Some Public Baths

PUBLIC pool bathing, often regarded as a boon to health is being viewed with suspicion by public health officials after a recent survey by 2,000 doctors in forty-one states which revealed that several epidemics of tonsilitis, colds, and skin diseases were traced to public bathhouses. Bacteriological counts in some pools revealed 4,000 bacteria per cubic centimeter of water, said to be from the skin and saliva of bathers. Except when rigid standards are set up, public bathhouses may be a menace to public health instead of a boon, medical authorities say.

Street Car Camp for Tourists

WHAT can be done with veteran street cars after they have become too old or too unfashionable to go jouncing over the thoroughfares? An enterprising man in Lawrence, Kans., has solved the problem. He bought six of them, removed their trucks, refitted them, and set them up as a tourist camp. Equipped with hot and cold water, showers, electric fans and lights, kitchenettes and libraries, the cars, seen below, have been turned into comfortable "cabins."

At Lawrence, Kans., motor tourists find six old street cars which have been renovated and divided into cabins provided with hot and cold water, kitchenettes, and many other comforts of the modern home

Plants Growing in Tree Tops Extend Roots to the Ground

PLANTS that perch on tree tops have been discovered in British Guiana by Dr. B. E. Dahlgren and are on exhibition in the Field Museum in Chicago. Air plants of the pineapple family, a flat-jointed cactus, and a yellow orchid are among those found in the top of a fig tree, growing in a mass which apparently existed as a parasite until its long roots, reaching down from the branches, were able to find the ground. Among the plants is a nest that was built by a colony of white ants, it is said, below which is a tropical variety of mistletoe.

Auto Horn Sets Traffic Light

SOON impatient motorists at suburban street intersections may change the red signals to green ones and drive by them at will, as shown below, simply by blowing their horns! Charles Adler, a Baltimore signal engineer, has devised a control for the traffic lights that can be operated by the horn's sound waves. Police are testing one trial installation on the outskirts of Baltimore.

The effect of the device is to keep traffic open constantly on a main thoroughfare, except when it is halted by one of the comparatively few drivers on the cross streets who wishes to pass.

The standard normally shows the green or go signal to cars on the main highway and the red or stop to those on the cross streets. A cross street driver, wishing to pass, sounds his horn directly into an ordinary telephone transmitter. This device picks up the sound and operates an electric relay that changes the green light on the main line to red and the red light on the cross street to green. The cross street driver passes. The device is adjusted to return automatically to normal at any determined time, say thirty seconds, after a cross street driver has changed it.

If the test system proves successful, other cities may adopt it.

How Charles Adler's device enables a motorist on a cross street to change the traffic lights by tooting his horn, halting traffic on the main highway to let him pass. Above: A demonstration of the electric mechanism by which sound waves of the horn are turned into impulses that operate the light

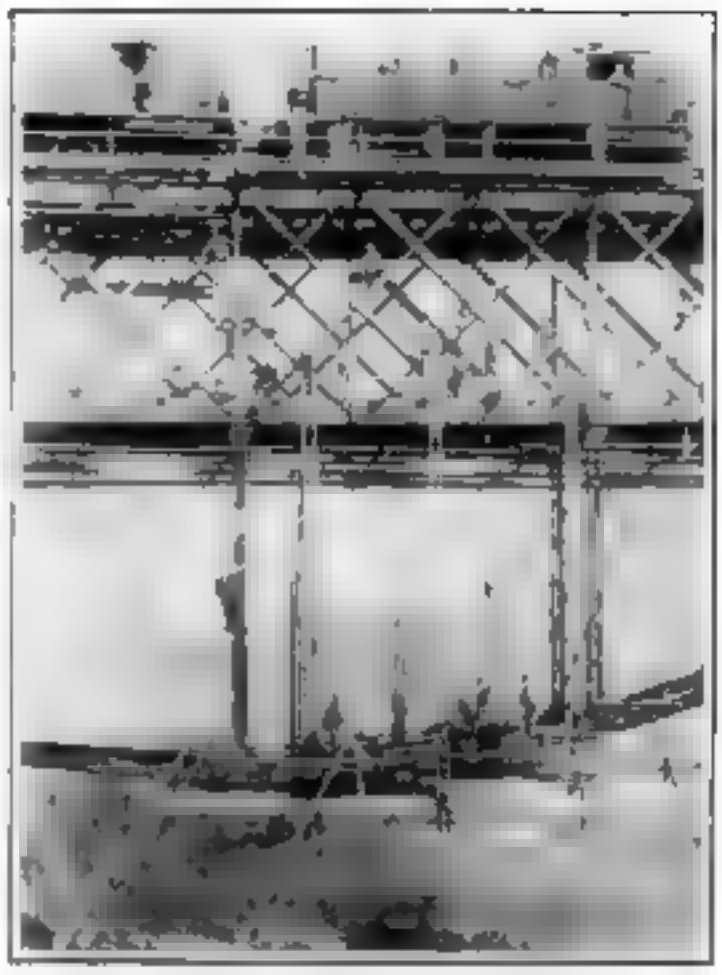
Astronomy's Silver Ball

ENGRAVED with the heavenly bodies known to sixteenth century astronomers, a solid silver globe, nearly a foot in diameter, valued at $100,000, which was fashioned by the Swedish astronomer, Tycho Brahe, was recently exhibited at the American Museum of Natural History in New York.

First to assign comets their place in the scheme of the universe, Brahe accurately recorded, too, the movement of the moon around the earth. Yet, curiously, he believed the earth the center of the universe, with the sun revolving about it, although the other planets, he said, moved around the sun.

Metal "Ears" Detect Planes

HUGE mechanical "ears," perfected by the Army, are now able to hear airplanes and dirigibles fifteen miles away, and find the range for heavy antiaircraft artillery, according to reports from the Frankford Arsenal, Philadelphia. Large horns, sixteen feet long, pick up the sounds, which are then amplified by vacuum tubes so listeners may hear the whirring propellers. Experts can tell the direction of the approaching planes by using two horns at once, one to operate vertically and the other horizontally. Searchlights took the place of guns in a recent sham battle when seven out of eight planes were "spotted" by synchronizing the movements of the sights as the metal "ears" detected the speeding planes.



Novel Test for Steel Bridge

HOW strong is a steel bridge? Railway engineers at Essen, Germany, recently tested the amount of vibration that this steel bridge will stand. Special recording instruments were designed and built for the tests, in which two locomotives furnished the action. An accurate knowledge of the structure's tensile strength was thus obtained.

First World Weather Maps

FOR the first time, the weather of the world is being mapped on a single chart to discover the laws of Nature which govern it. Scientists of the Smithsonian Institution at Washington have prepared large outline maps for compiling weather data such as wind velocity, barometric pressure, temperature, and rainfall, reported by 387 observing stations in both hemispheres, according to Dr. C. G. Abbot, secretary.

"Influences which affect a large area like North America will likewise affect areas like Australia," Dr. Abbot says.

By observing changes in climatic conditions, the effect of solar disturbances such as sun spots may be revealed.

Helping Nature Color Fruit

BY PROVIDING a means of deepening the color of pale yellow oranges so that they look more like the deep-hued variety, science has again come to the aid of Nature. Color in fruit is not always a sign of the flavor, but people seem to prefer the more brilliant toned oranges, although the lighter ones are often more tasty. By treating the fruit with ethylene gas, chemists have found it possible to develop a much deeper color in the protective covering without affecting the edible quality of the oranges, according to reports from the Agricultural Experiment Station of the State of New York. Apples may also be beautified by treating the soil with colorless chemicals like ordinary saltpeter, it is said.

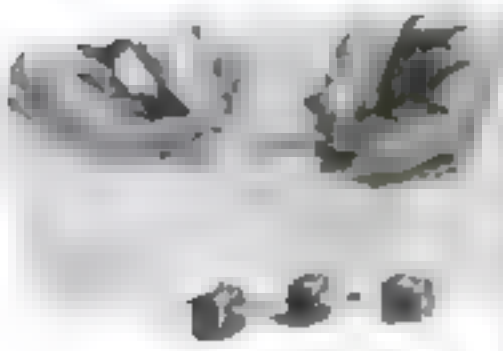
The "Iron Cashier"

The new German machine (left) opens letters, counts and sorts coins and coupons, and records totals in a book doing a man's four hour task in one

New Sealing Tool

This device (right) moistens the mucilage and seals the flap of an envelope in a minimum of time and with a maximum of efficiency, according to its inventor, and it saves wear and tear on the tongue

Fourteen New Products of



Pocket Heating Wood

Tool for Many Tasks

Lawn Mower Carries a Light

Helping the Deaf Hear Radio

Deaf persons hear radio programs through ear pieces with this device. A piece of hard rubber, resembling a pipe stem, is inserted in the jaw joint of a loudspeaker unit. It transmits the sound vibrations to the deaf person's auditory nerves when held behind ear

Seven Cylinder Plane Motor

Cigarette Lights Without Match

To light this new cigarette (left) you simply pull the paper tab protruding from the end. This novelty results after many experiments by John W. Lees, of Ventnor City, N. J., who invented it. The tab, impregnated with a chemical, rubs against another bit of treated paper when it is pulled, flame results

Easy Motor Signal

Hand signaling from the window of a closed car is made possible by this device recently brought out by a Western manufacturer. It is a "porthole" which can be installed quickly with special tools supplied by the manufacturer. When not in use the opening closes tightly

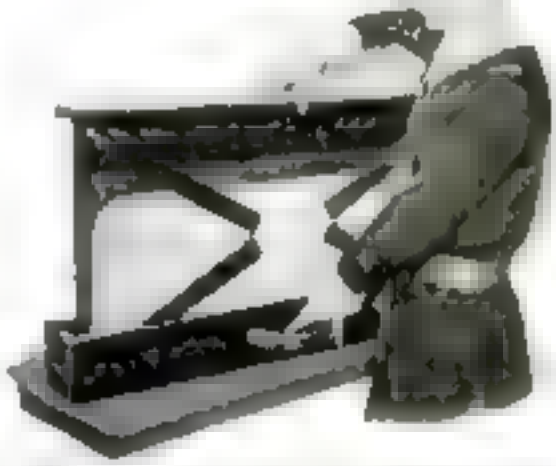
Inventive Skill

Overshoes That Fit in Pocket

Men who have a habit of losing rubbers will appreciate the latest protection for their shoes, a lightweight rubber "overcoat" that can be folded up and carried in the raincoat pocket for ready use when streets are wet. They slip on in a jiffy, and are inconspicuous enough to satisfy the person who objects to the inconvenience of ordinary rubbers

Automatic Lighthouse Can't Fail

At Burnham-on-the-Sea, England, acetylene and electricity combine in this new system. If one electric light fails, the failure makes the other flash into service. And if that becomes disabled it causes a magnetic relay to light the acetylene burner

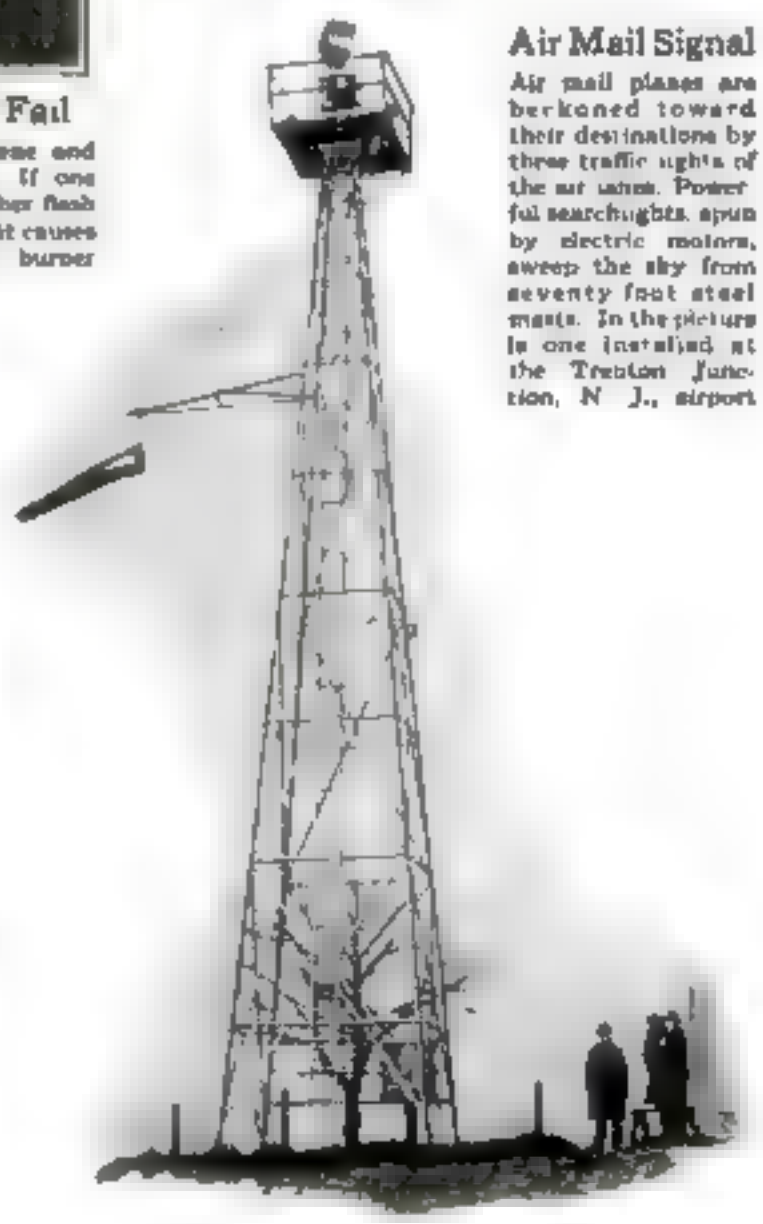


Folding Screen for Home Movies

A box holds the screen with its supports. When you press a button the screen unrolls like a window shade, and folding pieces of wood hold it taut

This Boat Rolls on Water

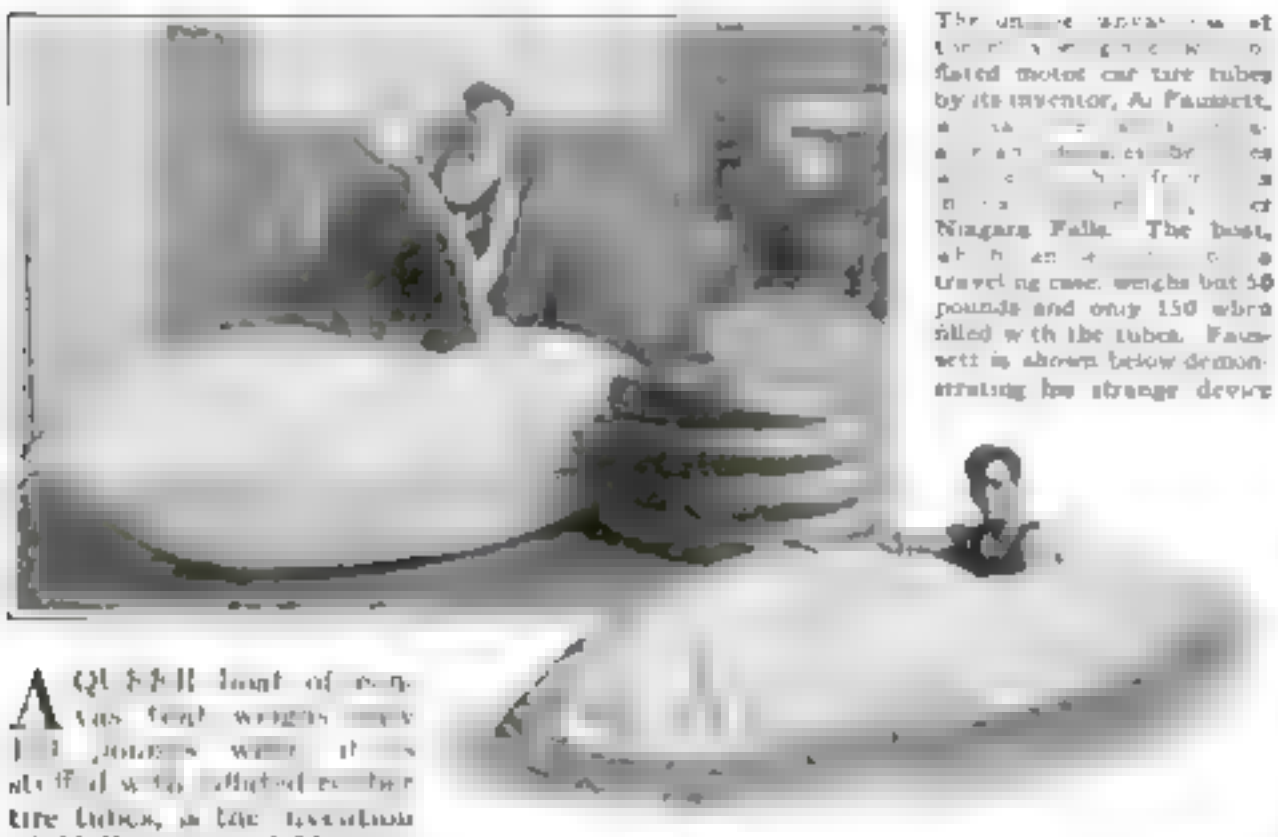
This curious boat is propelled by a small outboard motor. Inventor E. R. Thomas, by hydroplaning, receives the idea of the gasoline tank drums by way of being a "craft as it goes." This photo is taken at Miami Beach, Florida, as the pair of engineers see the craft being poured by the inventor's son



Air Mail Signal

Air mail planes are beckoned toward their destinations by three traffic lights of the air lanes. Powerful searchlights, spun by electric motors, sweep the sky from seventy foot steel masts. In the picture is one installed at the Trenton Junction, N. J., airport

Novel Boat of Canvas and Auto Tire Tubes



The ... inflated motor car tire tubes by its inventor, Al Faussett, ... Niagara Falls. The boat, ... traveling case, weighs but 50 pounds and only 150 when filled with the tubes. Faussett is shown below demonstrating how strange craft

A QUICK boat of canvas that weighs only [illegible] pounds when ... and if ... inflated rubber tire tubes, is the invention of Al Faussett, of Monroe, Wash. It may be folded into a flat case for transportation in a railroad baggage car like ordinary luggage. The inventor plans a leap over Niagara Falls with the novel craft. He says the tubes will protect him from the severe jolt and make sinking of the boat impossible.

Best Telepathy Letters

THE awards offered in February for letters on telepathy are on page 188 of this number, with the letters that earned the awards.

All Boys in 4 Generations

A FAMILY has been discovered in San Pedro, Calif., in which the male tendency is so strong that in four generations thirty-five sons have been born but no daughters. Some mysterious physical factor that is fatal to female embryos and is handed down from generation to generation might be responsible for this, Dr. C. B. Davenport, Director of the Eugenics Records Office of the Carnegie Institution, suggests. He would welcome reports of other such families to aid in finding the true cause. There have always been more males than females born, it is said, but the average does not explain the case of the San Pedro family. Statistics show 106 boys born to every 100 girls.

Huge Concrete Wall Moved

MASSIVE blocks of reinforced concrete, larger than freight cars and weighing seventy tons apiece, were recently cut from a twelve-foot wall more than eleven feet high and a quarter of a mile long, moved upwards of one thousand feet on rails to a new location at Long Beach, Calif., and cemented together again. Hydraulic jacks lifted each section out of a five-foot trench onto flat cars.

Two spacious gas tanks, originally surrounded by the wall, were floated into their new inclosure over an artificial lake which engineers made by constructing dikes along the route and flooding the ground with sea water

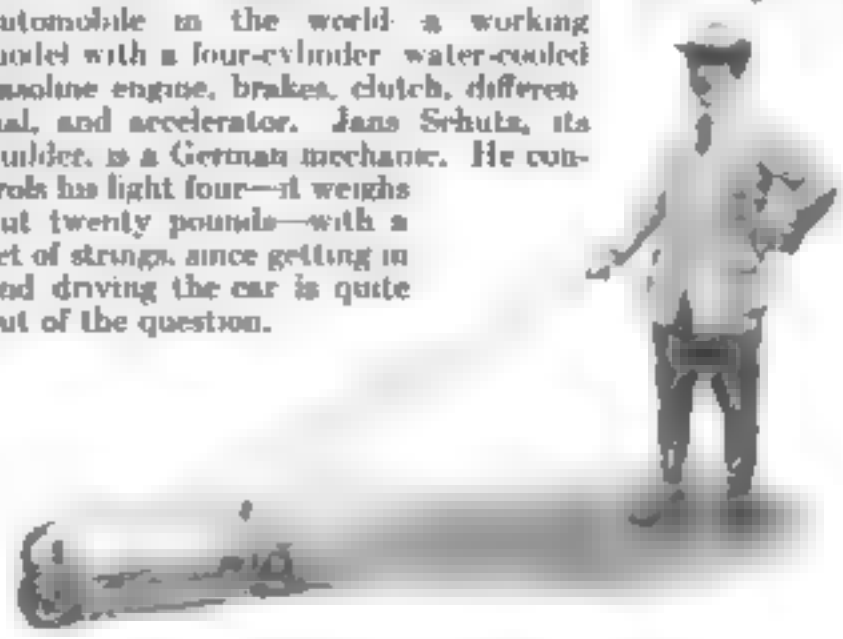
Radium Substitute Promised

WHEN scientists have learned how to harness artificial lightning in the laboratory, radium, now worth more than $2,500,000 an ounce, may be practically valueless, since a new and more powerful X-ray tube will do its work, declares Dr. William D. Coolidge, inventor of the present X-ray tube. Three million volts of electricity are needed to operate a powerful vacuum tube in order to produce rays as penetrating as those shot off by the particles of radium, and Dr. Coolidge has already found a way of using three ordinary X-ray tubes together at a capacity of 900,000 volts. If larger tubes can be made to withstand the artificial lightning, it will be possible to develop more emanations than a whole ton of radium would produce, according to Dr. Coolidge.

A short time ago, at the General Electric Laboratories at Pittsfield, Mass., F. W. Peek, Jr., produced artificial lightning of 3,000,000 volts, the highest voltage ever obtained.

Strings Control Model Auto

A SPEED of nearly seventeen miles an hour has been made by the car shown below, called the smallest real automobile in the world a working model with a four-cylinder water-cooled gasoline engine, brakes, clutch, differential, and accelerator. Jans Schuta, its builder, is a German mechanic. He controls his light four—it weighs but twenty pounds—with a set of strings, since getting in and driving the car is quite out of the question.



A German mechanic's twenty pound auto with four-cylinder, water cooled engine, whose speed is 17 miles an hour

Temperature of Mars Taken; Fifty Above at the Equator

DOES life exist on Mars? Would we be able to live there if we could bridge the millions of miles that separate us from the red planet? Scientists have come to various conclusions about the probability of life on Mars, and now Dr. W. W. Coblentz, of the U. S. Bureau of Standards, says—after observations at the Lowell Observatory in Flagstaff, Arizona—that if we should find on the planet sufficient air to breathe we should be rather uncomfortable without our winter overcoats. At the north and south poles of the planet, Dr. Coblentz says, the average temperature is seventy-six degrees below zero, while even at the equator the thermometer would hover around a chilly fifty degrees above.

Rays of light and heat reflected from the sun by Mars and its own invisible "temperature" rays were separated by screens of glass, water, rock salt, and fluorspar, and the "temperature" rays were concentrated on an electric thermometer in a vacuum. Two pieces of metal, joined together in the vacuum, turned the rays into minute electric currents, which, when measured by delicate instruments, disclosed the planet's temperature.

Tree Rings Reveal History

GIANT pine trees are growing in New Mexico which were saplings when Columbus discovered America, according to Dr. Albert E. Douglass, of the University of Arizona, who has made a study of the "fingerprints of time," the yearly rings of tree growth, in an effort to connect long past events in the region with the calendar of the civilized world. Similarities between the rings of these pines and the 2,000-year-old sequoia trees of California are expected to reveal seasons of drought or rainfall.

Brain Surgery Effects Cure

BY LIFTING a patient's scalp with keen-edged instruments, breaking skull bones with forceps, and then cutting away certain brain tissues, a case of epilepsy, dreaded disease of the brain, was recently cured by the famous Dr. Foerster, Professor of Surgery at Breslau, Germany, it is reported. Throughout the astounding operation the patient, who had traveled from Australia to consult the German scientist, remained conscious, while eager students crowded about to watch each move of the celebrated surgeon. Although his left hand is now paralyzed as a result of the removal of the brain nerves controlling it, the patient has completely recovered from epilepsy, and skin from his thigh has been grafted over the open cut in the bone under his scalp, which is once more securely in place.

Scientists Risk Death in Lava Lake to Film Volcano Kilauea in Action

In circle: A U. S. Government scientist photographing the Kilauea eruption from a rock ledge with a telephoto lens. Above: Night view of a fiery fountain in the lava lake. Below: Island of rock snapped as it sank in lava lake

CAMERA shutters are clicking and films are recording thrilling pictures as the mighty volcano Kilauea, in the Hawaiian Islands, seethes in its latest eruption. Daring volcanologists, on precarious overlooking eminences, brave noxious fumes from the boiling lava beneath them to train cameras on the mammoth show and preserve it for science. They have come from the near-by volcano observatory to make this the best observed eruption in history.

An unearthly glow over Kilauea's crater not long ago terrified Hawaiian natives. "The goddess Pele is angry," they said. The crater sprang into action.

Lava poured into its great basin, several miles across, to transform the normally small lava lake at the center into a huge caldron of boiling rock. A huge island of rock sank in a cloud of vapor; and Frank A. Perret, noted volcanologist on a jutting piece of rock above it, got a snapshot. At night he risked the terrible consequence of a misstep to film one of the fire-spattering fountains in the lava lake itself.

Dr T. A. Jaggar, in charge of the observatory, says the present eruption is one of a series that commenced in 1924.

A Subway Without Trainmen

LONDON'S new all-mechanical subway runs for six miles underground between branches of the Post Office Department, carrying forty-five tons of mail at a speed of thirty-five miles an hour without engineers, conductors, brakemen, or guards.

Small signal lights in a control room show the progress of the trains, and operators at the switches start and stop the cars by pushing buttons. Costing $7,500,000, after fifteen years in the making, the subway will save $200,000 a year, it is claimed.

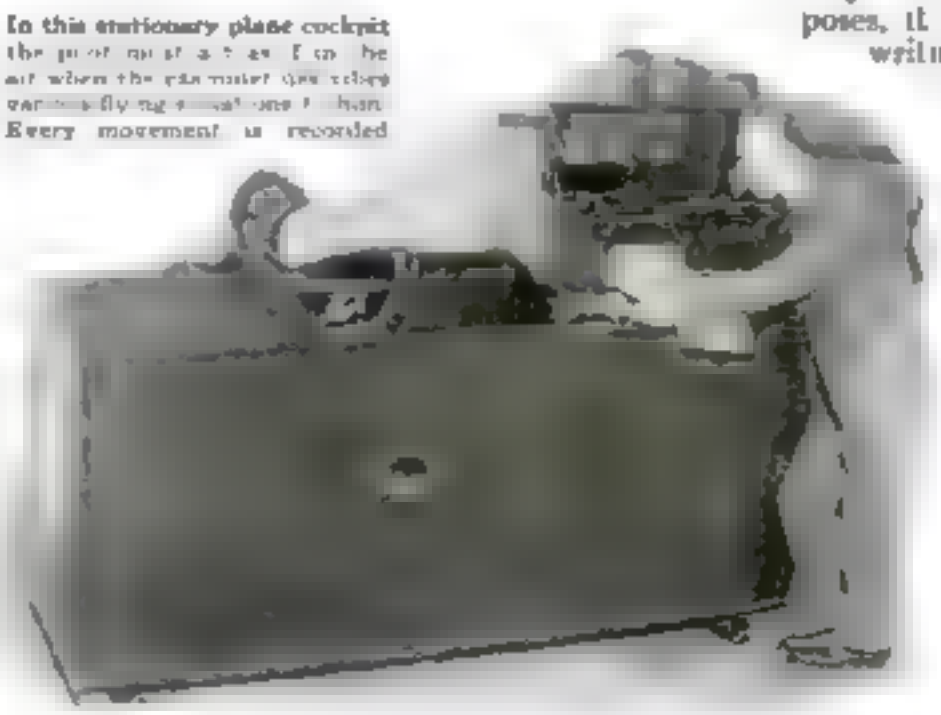
Old Paper Money Made Over

WHAT becomes of all the worn-out paper money? Formerly all old bills that became too ragged for use were cut up, ground into pulp and pressed into souvenirs for tourists who visited Washington. A new process of cleansing the pulp, however, makes it possible to remove the durable inks so that the pulp may be used over again for other purposes, it is said. A very fine grade of writing paper is one of the products of the new salvaging process, according to reports.

Novel Cockpit on Ground Tests Flyers' Ability

WHETHER prospective pilots will feel at home in an airplane is quickly determined even before they have left the ground by a novel apparatus recently adopted by the British Air Ministry for testing their fitness. Sitting in a seat like that of an airplane's cockpit, the hopeful candidate grasps realistic controls while an inspector barks at him, "Left bank! Spin! Nose dive! Stall!" What the would-be pilot does with his joy stick and rudder bar, in response to these imaginary emergencies, is graphically recorded on a charting device.

From an examination of the graphic record, the inspector can tell in a moment whether the applicant can fly a plane. If he has become excited and pulled the wrong control when he imagined himself in a nose dive, he is summarily rejected on the machine's recorded evidence. But if he has kept his wits and reacted speedily and accurately to every situation, he is adjudged to have "flying sense" and has qualified as a pilot.



In this stationary plane cockpit the pilot applicant is put when the examiner operates flying controls. Every movement is recorded

Any Questions?

THIS magazine is more than glad, whenever possible, to answer readers' questions on subjects within its scope and also to supply names and addresses of manufacturers of devices mentioned in its pages. Responses are made as quickly as possible, considering the time often required for research. Inclose stamped, self-addressed envelope and address Information Department, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.

Grain Transplanting Device Increases Crop Five Times

A NEW German grain transplanting machine sets out more than 12,000 plants an hour, one to each square foot, using one thirtieth as much seed as ordinarily used, and yielding from three to five times as many bushels to the acre, besides saving many times its cost in labor, according to the inventors. Sprouted seedlings planted in this way, having greater freedom for vigorous root growth, are said to usually develop from thirty to forty stalks a plant.

No Gear Shift in New Auto

ALL gear shifts may be eliminated from automobiles if the design of a new motor demonstrated in Philadelphia recently is universally adopted. One pedal feeds gas to the motor. Instead of being geared to the rear axle, this motor drives an electric generator, which supplies power to an electric motor to turn the rear wheels. Great flexibility and rapid pick-up are claimed by its backers for the new combination motor.

Blue Paint Joke on Baboons

WILD animals are being repulsed in the British Crown Colony of Kenya by grotesque but humane treatment which does away with the necessity of shooting them. Elephants, hippopotami, bushpigs, and baboons were recently surprised to find among their number a queer animal that resembled a baboon, except that it seemed to have had all its hair shaved off, and wore a coat of bright blue. So startled were they with this apparition that they no longer return to raid the colonists, according to the official who captured the baboon and released him after transforming his appearance with a razor and paint brush.

Transplanting Hawaii's Fish

"TRANSPLANTING" Hawaiian fish, prized for their food quality, to other parts of the world is the difficult feat being attempted by the trans-Pacific liner *Calawaii*. During the next voyage to the United States 500 fish will swim and leap in a specially constructed tank in the hold, as shown at right. Their water will be constantly replaced through pipes leading directly from the sea, and their comfort assured by an elaborate heating system. Should the fish survive this journey and removal to American waters via similar tanks on shore, it will be the first time in history that the tropical sea denizens have been successfully "transplanted."

First tests of the apparatus were made with 700 different kinds of fish in preparation for the actual voyage.

Trying the tank of heated sea water installed in the liner *Calawaii* to "transplant" 500 kinds of tasty Hawaiian fish to American waters

Smallest Fire Boats Fastest

WHAT are said to be the smallest and swiftest fire boats in the country have recently been put into service by the fire department of Portland, Ore., for use along the Willamette River. The boats, two of which are shown in action in the photograph, are but eighty-six feet long, but the three can concentrate 9,000 gallons of water a minute on a waterfront fire. Driven by 565-horsepower Diesel engines, they are capable of twenty miles an hour. The boats cost $100,000 each.

If Men Had Bats' Wings

BATS have such large wings in proportion to their bodies that man, to equal them, would have to develop ten-foot-long fingers with webbing between.

Radio Aids in Paper Making

A RADIO fan's idle trick of tuning out stations received on his radio set by slipping pieces of paper between the plates of his tuning condenser has resulted in the design of special radio apparatus to test the thickness and moisture content of paper manufactured in the mills at Bangor, Maine. As the paper is made, the fluctuations in the radio wave of a low-power sending set tell the machine tender whether the dryer is removing the proper amount of moisture from the pulp; thus the quality of the paper can be instantly and accurately regulated.

How Rocks Fan Mine Fires

COAL mine fires that rage underground long after all attempts to suffocate them have failed are kept alive by "breathing rocks," in the opinion of Prof. W. Spencer Hutchinson, metallurgist of the Massachusetts Institute of Technology.

By "inhaling" air when the barometric pressure is high, these porous rocks fan the fires in mines such as that at Butte, Mont. Although completely sealed by concrete walls, the mine continues to burn deep under the ground while miners work in new tunnels alongside.

How Much Do You Know of the World You Live In?

THESE questions are selected from hundreds sent in by our readers. Test your knowledge with them. Correct answers are on page 129.

1. What ancient American people anticipated modern astronomy?
2. Where is asphalt taken out of lakes?
3. What South American country was traded for New York City?
4. Where do railway cars run upside down?
5. Why are there no trees in northern Canada?
6. What is the Great Basin?
7. Where are the largest fossil bones found?
8. What grain crop grows under water?
9. What is a dingo?
10. What is the lowest place on the earth's surface?
11. Where are the helium wells of America?
12. Why was the gold of the Mayas and Aztecs purer than that of modern coins?

Biggest Electric Ocean Liner

HER powder [illegible] successfully completed at a [illegible] to the 23,000-ton ocean liner [illegible], largest merchant vessel ever built in this country and the largest in the world boasting an electric drive, was recently pronounced ready to go into commission. Three engine room tests instead of the usual "block gauge" of 400, mantled the twin steam turbines on the vessel's trial trip. Coupled to generators, they furnish seventeen thousand horsepower to the electric propeller motors. With the steam electric power, the vessel will leap forward instantly at the touch of a control — a flexibility impossible with steam alone. The ship will ply between New York City and Pacific Coast ports.

The turbines that develop 17,000 horsepower of electricity in the *California*'s engine room. Above: The new 661-foot electric ocean liner

Monorail Motor Bus Trains

"MOTOR trains," large automobile busses that balance themselves as they speed over a single rail track trailing a second car after them, have been introduced in Hungary to replace the usual railroads, according to latest reports from Vienna. Twenty-one of these gasoline driven monorail trains are already in operation on the State Railways, and are said to be more economical and a great deal faster than steam engines for light passenger service.

Know Your Car

A BROKEN-DOWN condenser leaves you absolutely stranded on the road

The condenser consists of two strips of tin foil wound into a compact roll with a piece of paper to insulate them from each other. One piece is connected by way of a wire to one of the breaker contacts, and the other to the remaining breaker contact. When the contacts are forced apart by the cam, the flow of current through the contact points and the primary winding of the spark coil is interrupted. The magnetic field created in the coil by the flow of current collapses and the moving lines of force produce a very high voltage current in the secondary winding of the spark coil. When the condenser breaks down, it no longer acts to store up the current that would otherwise flow through the contact points in the form of a spark; and so a strong spark occurs at the contact points and insufficient voltage is generated in the secondary winding to jump the gap of the spark plug.

As there is no way of repairing a broken-down condenser, it is a wise precaution to carry a spare.

Sounds Have Their Colors, Says Psychology Professor

DO YOU see a vivid color in your mind's eye when you hear a pleasant sound? Does a brilliant kaleidoscope flash through your mind when you hear a jazz orchestra, and do you see soft, velvety waves of a particular shade of blue when the church organ throbs?

Lawrence W. Cole, Professor of Psychology at the University of Colorado, declares at least two percent of human beings associate a particular color with each sound they hear, and sometimes this extends to the names of days of the week, and even to different odors. Children especially are likely to think of different sounds as having colors of their own. Harsh noises often seem black, while mellow notes will suggest a fantasy of golden color, says Cole.

Life Rafts Made of Kapok

MATTRESSES of kapok, a floating float resembling cotton, will soon be used on some ocean liners in place of the usual lifeboats, according to reports from Paris. Rafts made of four or more of the mattresses will be easier to handle than lifeboats because they will not be swamped by huge waves, it is said. Capt. Warneck, of the French Navy, suggested this use of the down obtained from tropical trees.

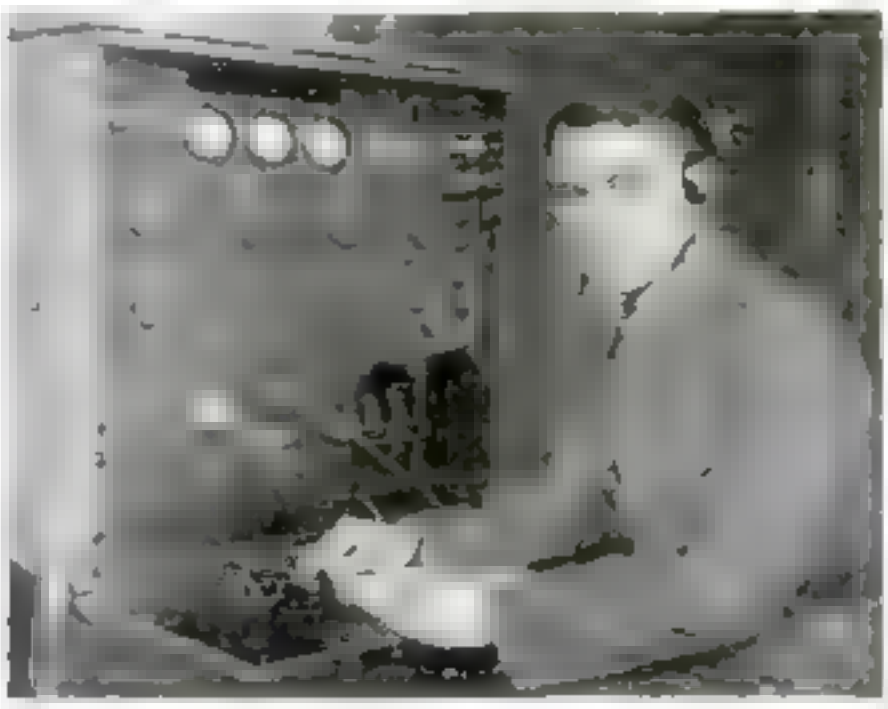
Theater Seats of Rubber

THEATER seats, chairs, table tops, and mats of rubber, all beautifully designed, were displayed at an exposition of the rubber industry in England recently to demonstrate new uses of the substance. The first rubber overshoes, with their original mold, which Thomas Hancock made nearly a century ago, were also displayed.

New Radio Talks to Flyers

ARMY aircraft far up in the skies may be directed from a dugout in the ground with the new portable radio set shown in the illustration below, developed by the Signal Corps. It may be packed up and carried from place to place as easily as an ordinary trunk. Only a few minutes are required to install it and put it in operation.

Morse code is used ordinarily, but the operator can throw his voice into the air simply by turning a switch and talking into a telephone mouthpiece. Both receiving and transmitting sets with electric generators to supply the power are combined into one compact unit. Although it uses little more energy than an ordinary electric light bulb, this small radio transmitter has a range of several hundred miles.



Communication with planes either by Morse code or speech is possible with this new portable radio set, developed by the Army Signal Corps. It can be set up anywhere and be ready for operation in a few minutes

A Host of New Devices for the Household

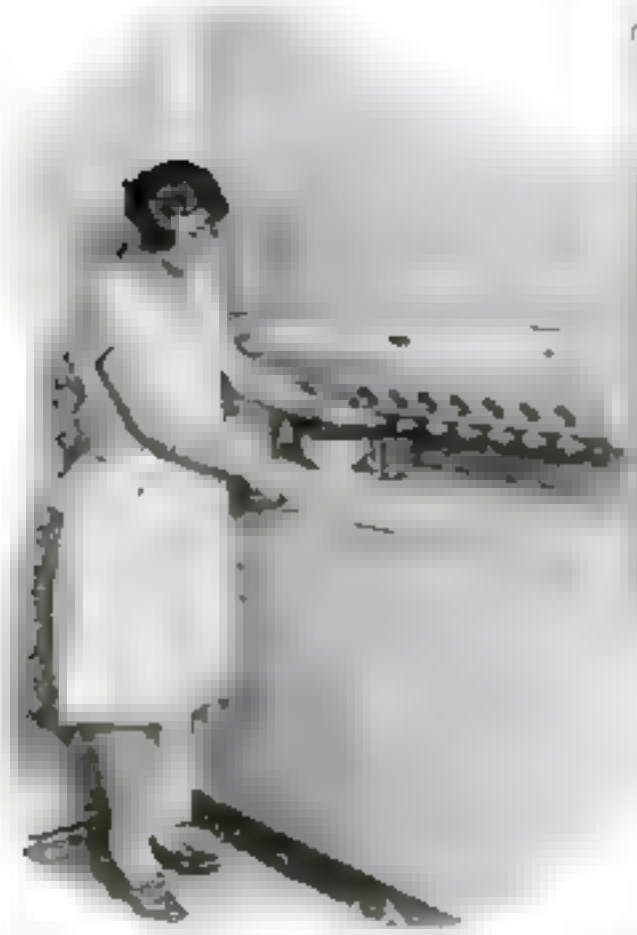
Stockings dresses coats all hang securely from this move hook. Store them out of the way in and when you want them they slip out sideways. A rolling muscle in a slot holds hem

You can lock yourself out with the new keyless lock. You close opens when you [illegible] kind of secret and only to yourself and the family. It can be worked in the dark

Food with flavor it is said when one of a new set of aluminum dishes a power beneath the pot. It diffuses the heat and preserves the food's flavor. There are [illegible] various pots and burners. When silver is to be cleaned or burnish put one of the blue [illegible] with hot water salt and soda drop the silver on top of it and the silver is heated through an electric reaction with the aluminum

Breakfast in bed can be made more [illegible] and inviting by a [illegible] tray with folding legs. Placed across the foot of the bed it has [illegible] and [illegible] for the morning [illegible] with the reading board. In the drawer [illegible] reading table. In the [illegible] says he makes [illegible] invaluable. It closes compactly for storage

Because a brush is made in such a way, a new [illegible] bright and easy to [illegible] the bristles shape [illegible] the hand [illegible] very easily. And of course it won't get wet in the bath and since it has the [illegible] bristle [illegible] The [illegible] are [illegible] to the brush so that they will not bother you by their shedding"



In the latest kitchen cabinet, a row of sanitary metal bins with convenient spigots holds such materials as sugar salt, and coffee. A touch of a handle and you fill a measuring cup in a jiffy. There is also a flour sieve

Two glasses rest conveniently in this new way that clamps to the side of your bridge table. They cannot [illegible] or spill [illegible] playing cards for they are [illegible] the way and two metal rings [illegible] them securely. An instant pressure of the fingers attaches or removes the ingenious tray

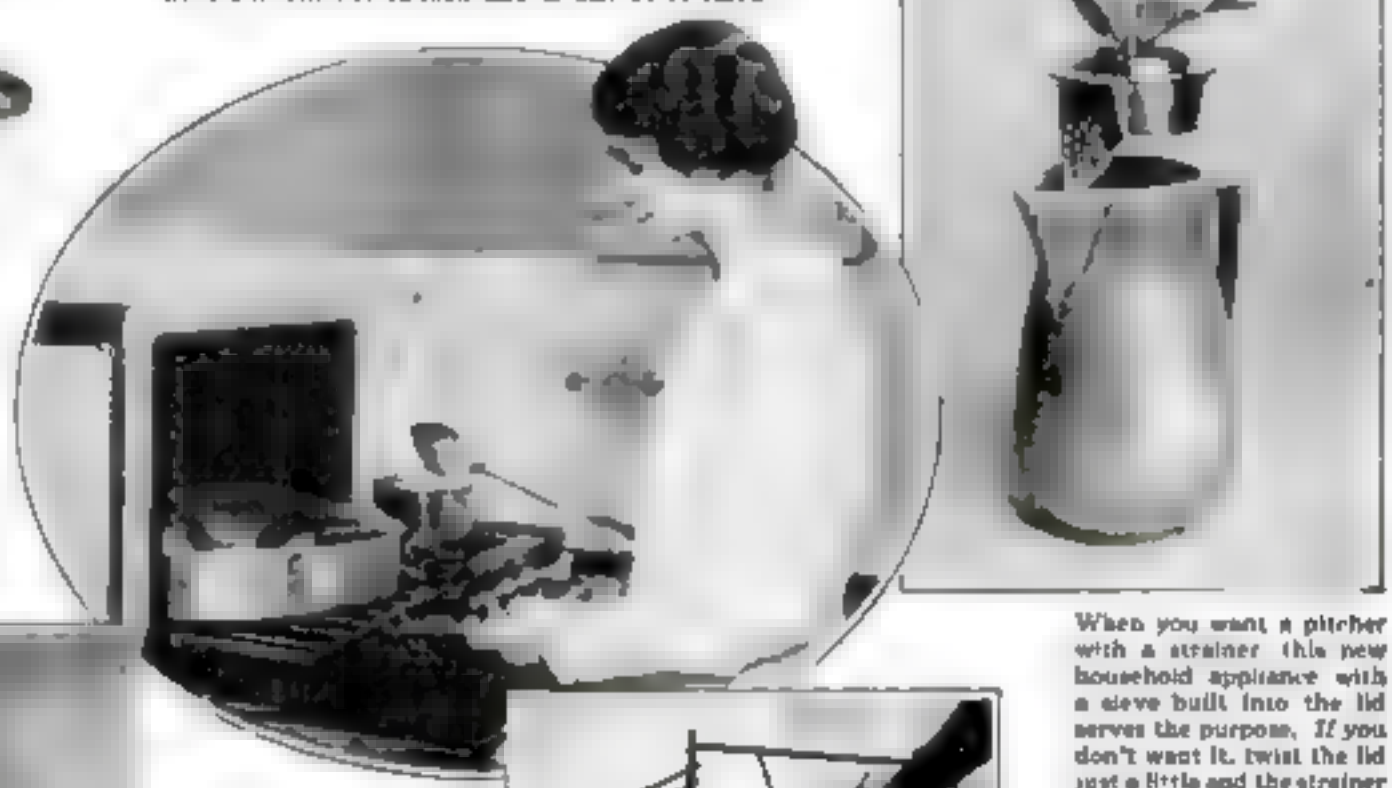
Every housewife knows that milk and cream will not sour quickly if it does not touch them. The new milk bottle stopper sleeve made entirely of rubber effectively seals the bottle and keeps out air. A knob serves as a convenient handle. A moment's rinsing in hot water suffices to clean it

This new attachment for your vacuum cleaner is also a squeak-remover for the springs of the automobile—but it makes a dandy air brush as well to paint your furniture. It all depends on what you put in the jar, whose spray nozzle hooks onto your cleaner

You can save a few precious seconds in the morning with an ingenious new toilet article that enables you to comb and brush your hair with a single motion! Within its compact closed shape, released by the pressure of a button, are two small combs that slip and lock into the sides for instant, rapid use. Press another button, and a hand mirror slides out from the top. Travelers will appreciate this device

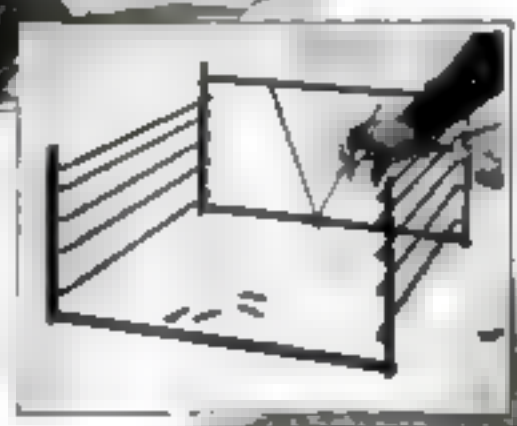
Apparently as soft as a sponge is this new kitchen appliance, a curly mass of copper for cleaning and polishing pots and pans; but its ability is marvelous, according to the maker, to remove rust, discoloration, and sticky food. It is said not to scratch

Screw a lamp with this new lock into your socket—and it will stay there for the life of the bulb. It cannot loosen with jarring or vibration, and no one ignorant of the secret can remove it, for it won't screw out in the ordinary way. Pull it downward a fraction of an inch and it can be released

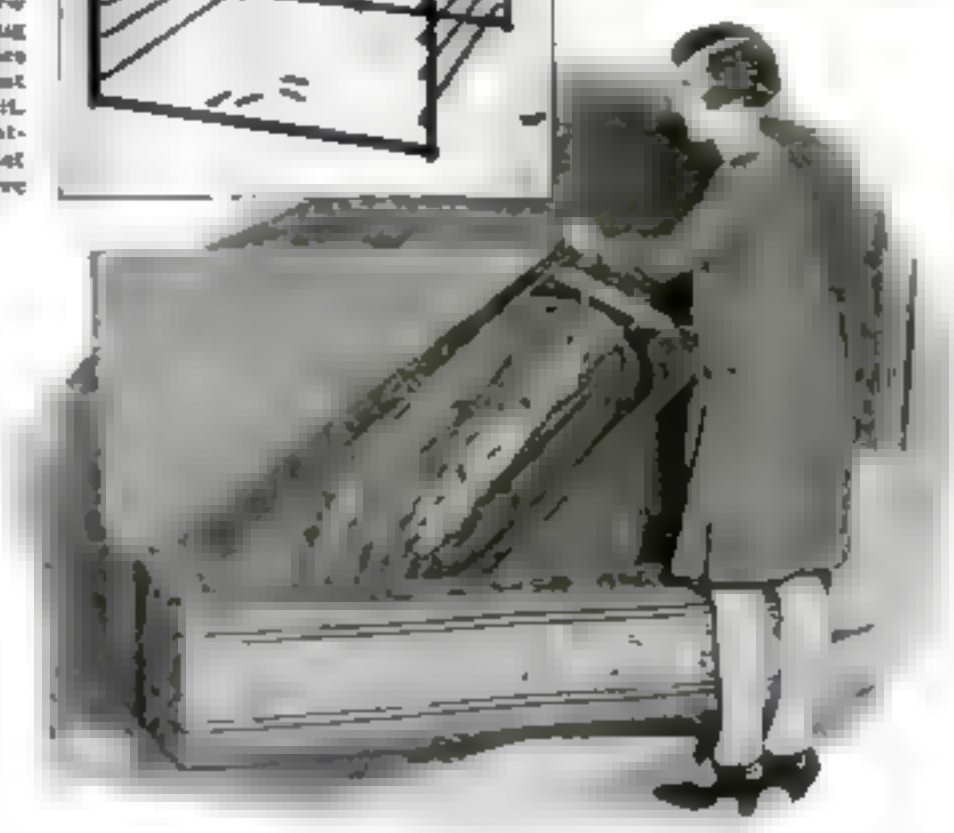


You can drop these electric plugs, for lamp or toaster, on the floor, step on them, even hit them with a hammer and they won't break. They're made of soft rubber and survive innumerable falls. The extra collar of rubber protects wires against fraying and minimizes danger of short circuits

When you want a pitcher with a strainer this new household appliance with a sieve built into the lid serves the purpose. If you don't want it, twist the lid just a little and the strainer disappears. It saves the nuisance of looking for a strainer when you need it



You won't burn your fingers, wrists, or arms if your oven is equipped with these new safety shelves. A tug on one, and it slides out, bringing the roast or the cake with it. The shelves are mounted on a framework that fits any cooking stove



Here's a brand-new way to keep the air in your home moist and fresh! The cabinet fits in your wall. Running water sprays through it and sucks in air at the upper register, to discharge a veritable "lake breeze" at the lower one. The water pipes run behind the wall

To all appearances, this piece of furniture, when closed, is an ordinary upholstered couch. But lift its hinged lid, and presto! a complete wardrobe swings out, on handy bars that serve as a stand. Fifteen holes are provided for as many dress hangers, making the novel chest a full-equipped closet-on-its-side. It was recently shown at a model home exposition and was praised for its space-saving features

How to Adapt Your Set to A.C.

A Complete, Practical and Simple Way to Electrify Your Old Receiver— A Method Approved by Our Institute's Engineers

By ALFRED P. LANE

Fig. 1. Testing A. C. adaptor hardware in commercial estate Institute of Standards laboratory

CAN I change my battery-operated radio receiver into a full electric model? Is A. C. conversion practical? What does it cost? What parts do I need? Is there much hum?

Those questions, and others on the same subject, are on the lips of radio set owners everywhere. Probably you have asked them yourself

Extensive experiments have been carried out in the laboratory of the Popular Science Institute of Standards to find out definitely and accurately just what you can do in the way of A. C. conversion and what results you may expect when the conversion is properly carried out.

These experiments prove conclusively that you can, by the use of the proper apparatus, easily adapt your old receiver for full electric operation, thereby making it as simple to operate and care for as any other household electrical appliance.

WITH full electric operation, you eliminate entirely the necessity of testing, charging, and filling the storage A-battery, and of replacing the B-batteries at regular intervals. In fact, you get rid of every attention and replacement required by the battery-operated set except the replacement of the vacuum tubes.

On the other hand, A. C. tubes are more expensive than those used in the battery-operated set and do not last quite so long. It is reasonable to expect, though, that both these disadvantages will be remedied in the near future.

Converting your set for full electric operation will not give you more distance nor make the set more selective. Neither will it bring any improvement in tone or volume if you are now using a type 171 power tube in the last stage. The sole gain is in freeing yourself from the work of taking care of a battery-operated set.

Experiments at the Institute of Standards have shown that almost any standard type of factory-built or home-constructed radio receiver may be converted for electric operation. In many cases the conversion can be accomplished without changing a single wire inside the radio receiver. Such receivers as the ordinary neutrodyne or balanced radio-frequency type, which are already arranged to use a type 171 power tube, can be converted without change. If they are of the older type, the B-supply wires inside the set must be changed to provide for the necessary separate high voltage to the power tube.

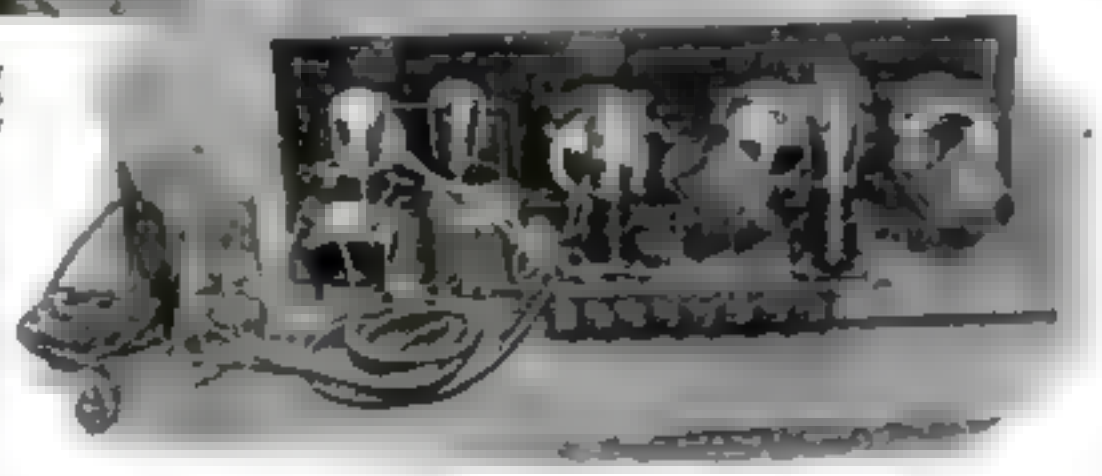


Fig. 2. An old home-assembled radio receiver converted for full electric operation. A B-eliminator, antenna, ground, and speaker complete it

Of course, where balancing condensers are used to keep the radio-frequency stages from oscillating, these condensers must be readjusted because of the slightly different capacity of the UX 226 alternating current tube as compared with the standard 201A battery tube.

RECEIVERS using the grid resistance method of preventing oscillation, where a high resistance is inserted in the grid lead of each radio-frequency amplifier tube, require no special treatment.

In older type sets, however, where the potentiometer method of preventing oscillation is employed, conversion to electric operation necessitates the introduction of some other means of controlling oscillation, because you can't use a potentiometer connected across the alternating current filament leads of the tubes. Inserting grid resistances will solve the problem with the least trouble.

There seems to be considerable confusion as to what constitutes complete electrification as that term is popularly understood. There are two distinct methods. One is to employ the new alternating current tubes such as the UX 226 and UX 227, using low voltage alternating current from a step-down transformer; the other is to build an A-eliminator consisting of a step-down transformer chokes, and filter condensers which will take the alternating current and convert it into low voltage direct current suitable for use on the filaments of ordinary storage battery tubes.

IN THIS article we consider only the first system—the use of the new A. C. tubes. In a future article we hope to cover the experiments now being carried on at the Institute of Standards laboratory with A-eliminator systems.

In converting a battery-operated radio receiver to full electric operation, certain parts of your present equipment are discarded and certain new apparatus must be purchased. Assume, for example, that you have a five- or six-tube radio receiver with the usual equipment. This means that the sockets in the receiver are supplied with 201A tubes except in the last stage of audio amplification. You probably have a 112 or 171 power tube in that socket. There is a six-volt storage battery under the table or in the lower compartment of the console cabinet. Next to it is a trickle charger or, perhaps, a full-rate charger. And beside the charger there will be three or possibly four 45-volt B batteries. In addition, there will be one or more C-batteries.

When you convert your set to electric operation, you will discard all the 201A tubes, the storage battery and charger, and all the dry cell B and C batteries. Obviously, if these parts are all nearly new and in perfect condition, throwing them away is wasteful, so the ideal time to consider converting your set to electric operation is when your tubes are no longer as good as they might be, the storage

battery no longer holds its charge and consequently requires too frequent charging, the charger no longer works efficiently, and the dry cell batteries are dead.

In electric operation, you retain the power tube and purchase new equipment as follows: UX 226 tubes to replace each of the 201A tubes except one, the detector. That one is replaced by a UY 227 tube. The next item is an A. C adaptor harness kit such as is shown in the foreground of the illustration in Fig. 3. In place of the storage battery and charger you need a special filament transformer with the primary wound for 115 volts and three secondary windings—one 1½-volt, one 2½-volt, and one 5-volt. A high-grade B-eliminator completes the needed conversion equipment.

ESSENTIALLY, conversion to full electric operation means substituting A C. type tubes and a step-down filament heating transformer for the storage battery type tubes and the storage battery. It still is, and probably always will be, necessary to use high voltage direct current for the plate or B-circuits of the tubes and you can, of course, obtain this kind of current from the light socket only by the use of a B-eliminator.

All the newest factory-built electric receivers use precisely the same equipment outlined for the conversion of battery sets except that in many of them the auxiliary equipment is housed in the cabinet with the rest of the receiver.

Of course it is entirely practical to convert a battery-operated receiver to full electric operation without purchasing a special adaptor harness. If you are sufficiently familiar with radio equipment to know what each wire is for, you can rewire the filament circuits for the A.C. tubes. A kit of heavy twisted wire pairs such as shown in the background of Fig. 3 will save a lot of time in such a rewiring job.

SEVERAL types of A. C. harnesses have been tested and approved by the Popular Science Institute of Standards.

These harnesses have been designed for the greatest possible adaptability, so that they can be used in a great many different types of sets.

The harness consists of a cable with several branches. Along this cable, like beads on a necklace, are strung a number of adaptors as illustrated in Fig. 3. These adaptors really are sockets fitted with prongs on the bases. They are placed in the regular sockets, and the A. C. tubes are placed in them as shown in Fig. 4. The internal wiring of the adaptor connects the grid and plate prongs of the tube straight through to the grid and plate contact springs in the socket in the receiver. The set socket filament terminals which in the battery hookup carried the storage battery current to the filament terminals of the tube are joined together inside the adaptor and are connected to the center tap of a biasing resistance placed across the A. C. filament terminals of the adaptor.

Send for This List

A special list of apparatus approved by the Popular Science Institute of Standards for use in converting battery-operated radio receivers for full electric operation will be sent to readers without charge. Address: Radio Editor, Popular Science Monthly, 250 Fourth Avenue, New York.

A special branch on the cable or a separate cable is provided for the five-prong UX 227 heater type detector tube and another, fitted with a biasing resistance, is used for the 171 power tube. The regular battery type 171 power tube has been found to be perfectly satisfactory for operation on alternating filament current.

After the adaptors have been placed in the receiver sockets and the A C tubes have been placed in the adaptors, the cable ends are connected to the binding posts on the filament heating transformer.

Short-circuiting the C-battery binding posts on the receiver and connecting up the B-eliminator to the regular binding posts on the set complete the work if the receiver is adapted for use with the 171 type tube, which means practically all the good radio sets made recently

Fig. 3. In the foreground is a complete A. C. harness adaptor outfit In the background is a simplified kit of only the necessary twisted wire

With older sets, either factory built or home assembled, additional problems are encountered. If the set is fitted with the old type sockets, care must be taken to select a harness fitted with adaptors that have pins so that they will stay in place.

Fig. 4. The tube prongs fit into the adaptor and adaptor fits into socket

In order to take full advantage of full electric operation in an old set, at least one change in the wiring is absolutely necessary. Such receivers usually are wired so that ninety volts is applied to both the first and second stages of audio amplification. The 171 type power tube requires 180 volts on the plate for maximum results, so you will have to locate the plate supply wire to the last tube and bring it out to a separate binding post. Locate the lug on the loudspeaker jack that is wired to the ninety-volt binding post. Disconnect the lug from the wire. If it is a branch that goes nowhere else, take it out entirely. If the wire continues to some other part of the set, merely unsolder it and move it out of contact, making sure that it does not touch any other wire and that the ninety-volt supply to the balance of the set is kept intact.

NOW run a wire from the lug that you have disconnected to a new binding post for the 180-volt supply.

Fig. 2 shows a typical example of an old home-built radio receiver converted to full electric operation. This receiver is the original model from which was prepared the radio construction article which appeared in POPULAR SCIENCE MONTHLY for July, 1925. It has been in daily use since that time and no changes have been made in it since it was built except to substitute a new first-stage audio transformer for the original one which burned out. This set in revised form, allowing the use of the 112 type power tube, is detailed in POPULAR SCIENCE MONTHLY Blueprint No. 43. The original circuit did not provide for a power tube so one change in the wiring was necessary. The loudspeaker jack was wired to one of the unused A-battery binding posts so that 180 volts could be applied to the power tube type 171. The illustration of Fig. 2 shows the A. C. conversion harness and adaptors in place with the A. C. tubes in the sockets and the ends of the cable connected to a filament heating transformer. The output transformer is connected in the loud-speaker cord.

One way to avoid making any wiring changes in even an old set is to operate it with either of the power amplifier and current supply units described in detail in the March and April numbers of POPULAR SCIENCE MONTHLY and in Blueprints 80 and 81. As these power units include the second stage of audio amplification, you can forget about the output transformer and entirely eliminate the last stage in the set. All you need do is locate the P terminal of the first audio amplifier socket and run a wire from it to the P terminal of the power unit.

If you desire additional information on some particular point, the staff of the radio laboratory of the Popular Science Institute of Standards will be glad to help you: provided, of course, that you state your problem clearly and in full detail. Address your letters: Radio Editor, POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York.

Right and Wrong Ways in Radio Work

Repairing Your Own Set

How to Use Solder -Fixing Parts That Fail -Choosing Special Tools

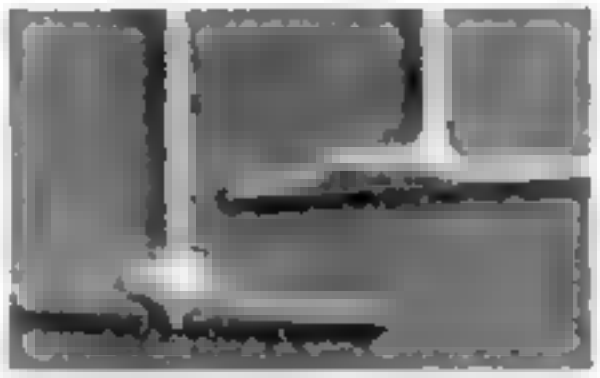
MAKING a good soldered connection is simple and easy, yet most beginners approach a soldering job with fear and trembling. They anticipate failure and, in most cases, unhappily, their worst fears are fully realized. The beginner constructing his first radio receiver may be ever so careful to get each connection exactly right. He can spend hours of time making sure that mechanical assembly and all other details are properly carried out, and then the set will refuse to operate merely because the soldered connections are like the one shown at the left in the accompanying illustration; whereas if they had been made as shown at the right, the set would have functioned perfectly until the tubes or batteries gave out.

These two connections, showing the joining of a piece of bus wire to another one at right angles, were specially prepared in the laboratory of the Popular Science Institute of Standards. The same solder, the same electric soldering iron, and sections cut from the same piece of bus wire were used in both cases.

WHY is one connection hopelessly poor and the other perfect? The answer lies in the amount of heat applied to the joint. It is absolutely necessary to get the metal surfaces to which the solder is expected to stick just as hot as the molten solder. Of course, you can't expect solder to flow on to a dirty, corroded metal surface and make a perfect joint, but even if the surface is clean and fresh you simply cannot get a good joint unless you keep the iron in contact long enough to get the metal properly heated. Nearly all amateur soldering troubles are due to "cold joints—mere gobs of half congealed solder stuck to the surface of the metal by rosin or soldering paste. Don't be afraid that you will get the joint too hot. The only chance for trouble is that the heat will run up the wires and singe the insulation and it is better to singe the insulation than to have a poor connection. Soldering really is much easier than it looks. Watch out for cold joints, keep your iron well tinned and hot, use good solder, use rosin or good soldering paste as a flux, make sure that the metal surfaces are clean, and you will master the art in a surprisingly short time.

Repairing Radio Parts

WHEN your radio receiver stops working the first problem is, of course, to find out what has gone wrong. The next is to remedy the trouble. If it happens to be a broken connection the remedy is obvious, assuming that you can get at the connection. But if the connection has broken inside a sealed-in part



Two joints made with the same solder and soldering iron from pieces of the same wire. The left one is a failure because of insufficient heat

such as an audio transformer, it really pays to send the part back to the factory for repair. Audio transformers are wound with very fine wire, and unless you have had considerable experience in fine electrical work, don't tackle repairing one.

However, there are a number of troubles that can be remedied by anyone with a knowledge of ordinary mechanical principles. For example, if you discover that the spring contacts in the socket are not making contact with the tube prongs as well as they should, you can bend the springs upward if the sockets are of the old type. With the new "X" type sockets where the prongs of the tubes push through holes in a plate and the contact springs press against the sides of the prongs, it is not so easy to make repairs. But fortunately, the new "X" type sockets rarely give trouble. If one does, the best remedy is to replace the part

A B C's of Radio

IN THE early days of radio broadcasting, when ordinary vacuum tubes were hard to get, cost from six to nine dollars apiece, and used four times as much current from the A-battery as modern tubes, reflex type circuits were popular.

In the typical reflex circuit, one or more tubes were made to do double duty. They were called on to act both as radio-frequency amplifiers and as audio amplifiers. With this system, better results than could be had when each tube did just one job were obtained. However, this advantage was very largely offset by the fact that reflex circuits were hard to adjust, prone to mysterious squeals and rarely gave the results of which they were theoretically capable.

Obviously, it is impossible to obtain by reflex methods results that cannot also be obtained by simpler circuits where each tube does one thing only. In these days of cheap, easily obtainable vacuum tubes that use only a small amount of current, reflex circuits are no longer popular.

Variable condensers are so well made today that trouble with them is extremely rare. Bearings practically never wear out, but sometimes an adjusting nut will come loose and allow the shaft to wobble in its bearing. When this happens, you will have great difficulty in tuning-in the weaker stations. The setting will never be the same two days running, and often a light touch on the dial, without turning it at all, will throw the set out of tune.

THE cure is to tighten up the loose nut. Study the construction carefully and do not apply more force than is needed to make the nut tight. You may find that the whole adjustment has come loose so that the plates touch each other at some point on the dial. Be sure to center the plates as closely as possible before you tighten the lock nut.

Old type rheostats often give trouble. The contact arm loses its tension and thereafter makes a poor contact with the resistance wire. The remedy is to bend the contact arm so that it will press more tightly against the resistance wire. With some types of rheostats, this can be done by a slight blow on the contact arm close to the hub. In most cases, however, this results only in making the condition worse, and a repair can be effected only by taking the rheostat apart.

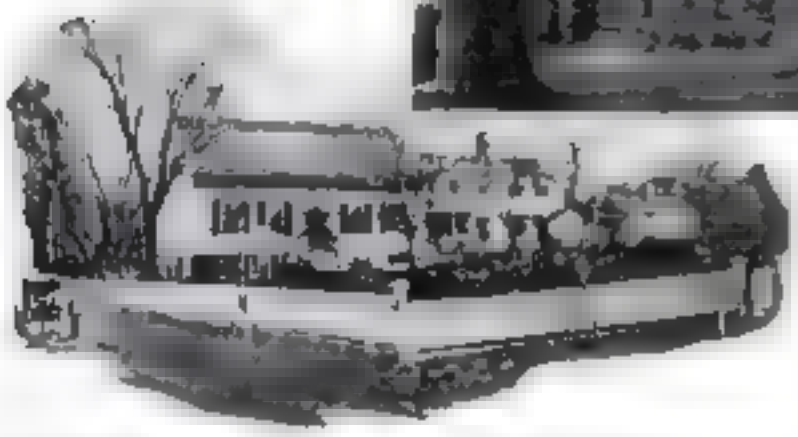
Special Tools Save Time

MANY difficult jobs in assembling radio parts into a set become easy if a long, thin-shanked screw driver is in your tool kit. It will permit you to get at mounting screws that are down between two parts where there is no space for fingers or a hand holding an ordinary length driver. A very short, small screw driver also is useful in cases where there is but little room back of the screw. In extreme cases of this kind, the right angle screw driver can be used.

Many amateur radio fans attempt to get along with only one pair of pliers, and frequently it is one borrowed from the automobile tool kit, in which case it is almost always much too large and clumsy for work on a radio receiver. Generally you can cut wire with it only by opening the jaws to the full extent and placing the wire to be cut in shearing notches near the hub. You might struggle for half an hour to figure out a way to accomplish with such pliers a particular job that could be done easily in a few seconds with either side-cutting wire pliers, a round nose plier, or a small flat nose plier.

It may seem extravagant to purchase special tools for radio work, but you will find that they will eventually more than pay for themselves in time saved in the many odd jobs around the house.

WHAT building problems do you face? Mr. McMahon will be glad to help you solve them. Write to him in care of the Home Building Department, Popular Science Monthly, 250 Fourth Avenue, New York, New York.



A photograph made in 1860, and, at right, another made recently

WHEN Napoleon Took Moscow This Home Was New, When Lee Surrendered to Grant It Was Old, and Now, After 116 Years, the Noble Old

House Starts Life Over Again

By JOHN R. McMAHON

"MARTHA, how about building that new house?

"'Times are unsettled, Hiram,' replied his wife. 'The almanac says, "Don't start anything in 1812."'

"'Well, we've just started a new war with England,' chuckled the head of the house. 'I hear Napoleon has started into Russia, and maybe that is what the warning applies to.'

"'It might apply to us too.'

"'Nonsense, Martha. These disturbances last for a little while. A good dwelling lasts a hundred years or better.'

"'Then you think this house will be still useful in—say—1928?'

"'Yes, my dear. People will be living in it and thanking us for putting up such a substantial, cozy structure.'

"'What an optimist you are, Hiram! If betting were not sinful, I would wager against you. However, let us build, and time will tell.'"

It is the duty of the writer to record that Hiram won the theoretical bet by a wide margin. His house stands today, a showplace in a picturesque suburb, Bogota, N. J. America got through with the War of 1812 and Napoleon got good and through with Moscow, but after 116 years the homestead is still going strong.

True, the house has been reconditioned, but the main elements remain. Time has levied lightly on the brownstone foundations, the hand-hewn oak framework, joists, and rafters, and planks put down as flooring. Most of the windows are in the original state.

"How did you come across this place?" I asked the present owner, Carl E. Dingfelder.

"We lived in the neighborhood for several years,' was the reply, 'and I always liked the quaint appearance of the old house. Then I went through it and fell in love with it—but my wife didn't."

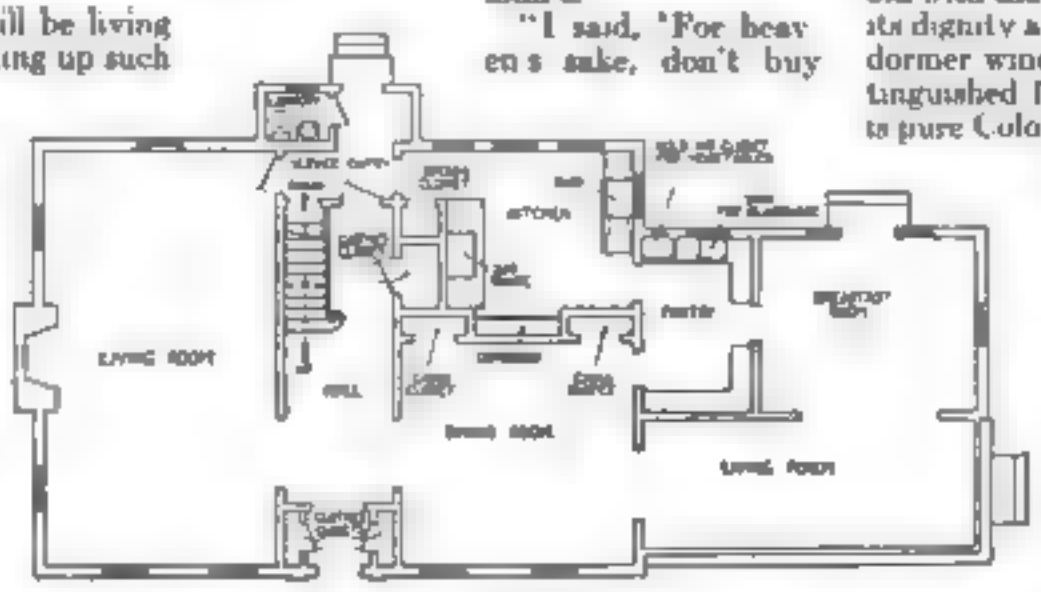
"I said, 'For heaven's sake, don't buy it!'" corroborated Mrs. Dingfelder smiling. "It was dark and spooky looking. The upstairs was cut up into about ten little bedrooms with open rafters for ceiling. Queer nooks and corners, creaky floors."

"It didn't look promising to a spick-and-span housekeeper," agreed the husband, "but I knew everything could be fixed up. So I bought it and called in some artist friends to advise."

"And they suggested the changes?"

"No, their final verdict was 'Don't touch it! It is more beautiful now than you can ever make it.' They saw the house as a picture, not as a habitation. I called in an architect to reconcile the old with the modern. I think he enhanced its dignity and beauty, notably by adding dormer windows and replacing an undistinguished front entrance with one that is pure Colonial—curving stone steps and iron railing, white pilars and deftly carved lintel. It has the charm of yesteryear's divided door, upper and lower halves separately hinged.

"It would be hard to trace the entire life history of this house," said Mr. Dingfelder. "Here's a photograph of it taken in 1860 that shows clapboards on the outside walls. These were covered with hand-made wood shingles when I bought the place and we



FIRST FLOOR PLAN

How the first floor was enlarged to make spacious living room, living porch, dining room, breakfast room, ample kitchen, pantry, and convenient extra lavatory

The living room. With rather low ceilings, bracket lights serve better than central illumination. The interesting windows of 18×2 have been retained with wisdom and with appreciation of their beauty

kept them intact. The photograph shows three chimneys, which were restored to two when we arrived. I replaced them with one large outside chimney."

"It was a good idea," I observed, "as helpful to the general appearance as the new front entrance. How did you start alterations?"

"We began at the ground floor and transformed two adjacent bedrooms into a large living room. I wanted an open fireplace here and that fixed the location of the new chimney. The walls and ceiling got new wood lath and cement plaster instead of the old lime mixture. You notice the inner wall has large decorative panels in cream plaster with slate gray wood moldings. The object is to avoid the effect of long bareness, breaking up the lines of surplus length. On account of the rather low ceiling—eight feet or so—we have no center light but depend on wall brackets and other lamps."

"Was the oak floor laid over the old surface?" I inquired.

"Yes, and the original white pine planks made a good base," replied Mr. Dingfelder. "They were a foot wide and three inches thick. The modern subfloor is one inch thick. About the only change in the windows of the living room was to shift the location of one on the west side to balance its mate."

"Balance means equal distribution of light as well as looks."

"EXACTLY—a point many persons overlook. A curious detail of the windows is that they are hung not with cord but with brass strips that roll up on springs. No doubt this was a fancy improvement added to the house half a century or more after it was built. We have added storm windows on the north and west sides of both floors. This takes the place of weather stripping. They are, naturally, more expensive than stripping, but may be economical when you consider fuel saving."

"About five times as much heat escapes through a window as through an average solid wall," I remarked, "and you cut that loss in two by having double windows. I mean loss through the glass itself, not air leakage around the sash, which may be as much again."

"There is a chance for an inventor on that problem," said Mr. Dingfelder.

"What did you tackle after the living room?"

"The hall, but we did not change its dimensions. The old stairway was replaced with a new one—mainly an improvement in materials. A coat closet was built in and of course the walls were replastered and oak flooring laid. We converted the old sitting room into a dining room. As elsewhere the original small-paned windows were left intact. An inside partition wall was rebuilt to contain a pair of inset china closets with arched tops in the Colonial style, spaced to give room for a sideboard between. They do not project into the next room, thanks to the architect's ingenuity in housing between them in that next room, the kitchen, an inset kitchen cabinet.

A dining room corner showing one of the built-in china closets and part of sideboard fitting between them

"The kitchen occupies what was once a bedroom, and has every modern feature, including an electric refrigerator in an entry hall."

The present owner extended the first floor to provide for a butler's pantry, a breakfast porch and a sun parlor, the latter practically all glass on two sides, with French doors, and floored with English quarry tile of irregular outline and colorful combinations.

The butler's pantry contains a cold-air closet—one of those lost inventions rediscovered by a bright modern mind. Everybody can afford it and the handy man can make it. You keep vegetables, fruit, and such like in it, saving many steps to the cellar. This particular model is six feet high and two feet square inside. At the back two screened openings about ten inches square extend through the house wall to let in cold air.

ON OUR way upstairs I took note of a lavatory in the rear hall. Besides this, there are now three complete bathrooms in the house. Shades of the ancestor of 1814! He did not have one bathroom.

"How did you deal with the spooks upstairs?" I asked Mr. Dingfelder.

"They were easily abolished by letting in more light," was the reply. "This was done by taking down partitions, adding a few windows, supplying a ceiling, and raising the rear roof. There is a master bedroom seventeen by twenty-six feet with its bath, and two guest chambers with another bath. Then there is simply the hall with large linen closet and a cedar closet. On the north side the roof was raised to give a level ceiling. The attic space is small and unused. Insulation of the attic against heat and cold was unnecessary because of the extra heavy sheet copper roof covering."

"Copper is the reverse of a good insulator," I remarked.

"Yes, but it is laid over wood shingles. I had the entire house covered with creosoted wood shingles. They were all right except on the north roof, which had been raised to an angle that gave too low a pitch for shingles. Rain would get under the shingles and cause leakage. There are different pitches suitable for various types of roofs and the least allowable for shingles of any kind is six inches per horizontal foot. Copper is most expensive, but more enduring than tin and more fire-safe than zinc. If zinc had been used there might have been a question about contact with the red cedar shingles, since the acid in this wood affects the metal."

"WELL, your roof problem is solved for another hundred years," was my comment. "No painting or repairs. The standing seam style which you have is generally safer against leakage than flat seam. Since the job was done by competent men, I know care was taken to avoid expansion trouble and the roof is properly grounded to carry off electrical discharges."

It may interest the reader to know that (Continued on page 130)

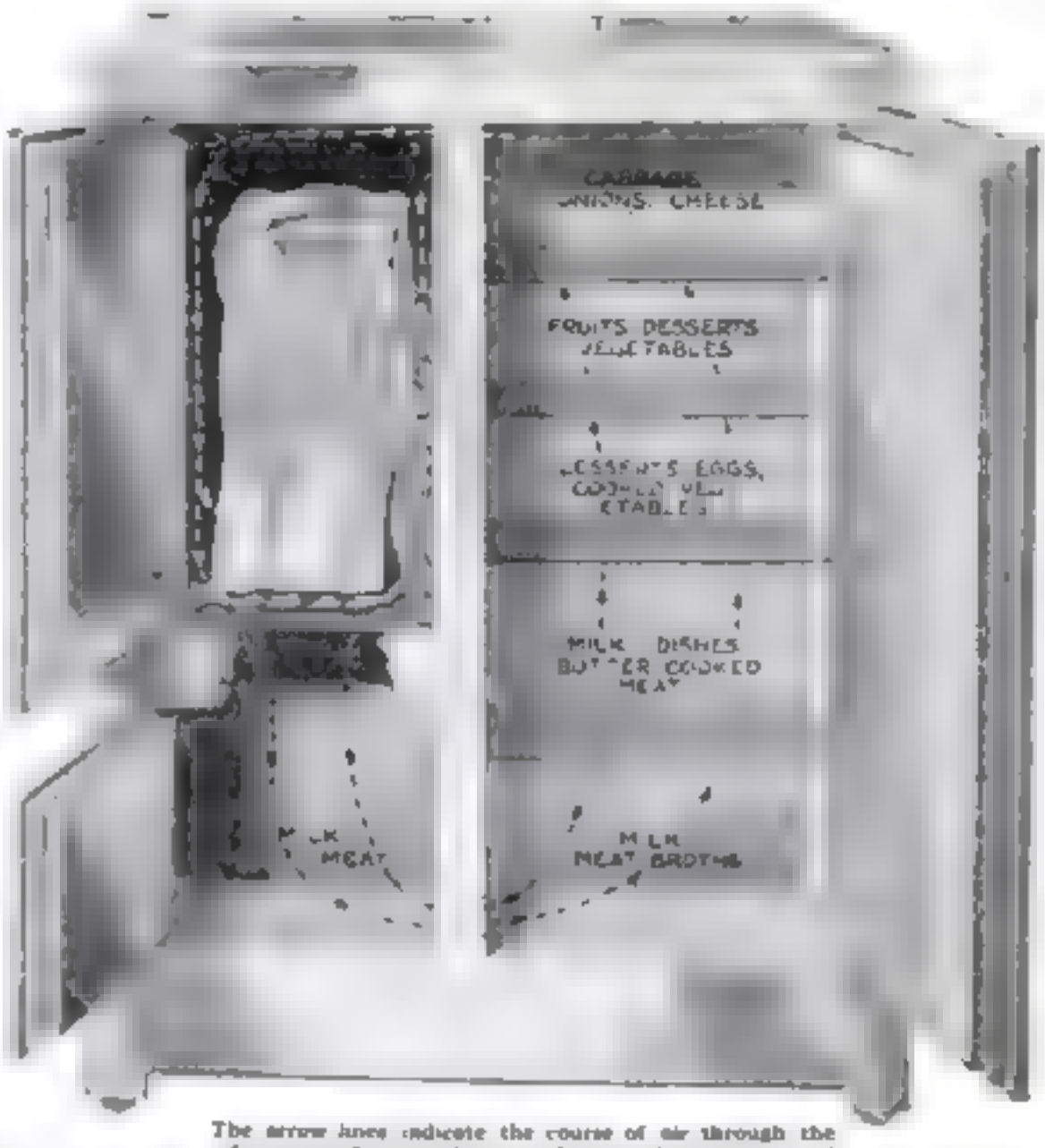
Why Most Home Refrigerators Are Really Worthless

By FREDERIC DAMRAU, M.D.

AMONG other luxuries in a great new apartment building near my home there is a beautiful private ballroom for the use of the tenants. Each apartment is equipped with pretty nickeled white enameled refrigerators. But nice as they are to look at, as refrigerators they are about as effective as so many white soap boxes. Actually, they will endanger the health of the families that use them.

Your icebox—or the one owned by the richest man in the United States—is good only in proportion to its ability to perform its appointed function. And the one function of an icebox is to keep food cold. If it does that it's a good icebox. If it doesn't, it isn't, and no amount of enamel will make up for its failure.

Of course, if people knew the dangers that lurk in improper refrigeration, it would take a good deal more than a ballroom to offset those poor refrigerators. Really alarming is the fact that most refrigerators now in use are practically worthless. This fact, mentioned in my previous articles, has been amply substantiated. Millions of refrigerators do not perform the necessary function of a refrigerator at all.



The arrow lines indicate the course of air through the refrigerator showing why open shelves aid circulation and why various foods should have certain places in the box

AN icebox to be efficient and safe for food preservation should maintain temperatures of fifty degrees or less in all compartments and forty-five degrees or less in the milk compartment.

Good refrigerators are made and sold. The Popular Science Institute of Standards tests many good as well as bad ones for use either with ice or with automatic units. However, wide public ignorance of the importance of effective household refrigeration has brought about a demand for cheap refrigerators, and so even reliable manufacturers have been forced to save on materials and to produce refrigerators which do not at all do the job they are intended to do.

Insulation is the most important and, perhaps to the average householder, the least considered feature of an icebox. It is to the icebox what the vacuum jacket is to the thermos bottle. When a refrigerator is poorly insulated, heat rapidly penetrates its walls—melts the ice and raises the temperature to unsafe and even dangerous levels.

Proper insulation means lining the icebox with a material, preferably two inches or more in thickness, which conducts heat very poorly and allows the food compartments to remain cold in spite of high temperatures outside. Insulation should be so effective that when the room temperature is eighty degrees a thermometer placed in the food compartment will not register above fifty.

Wood, felt, paper, or just ordinary air are "insulators" commonly found in cheap iceboxes and are grossly inefficient, especially when they become moist.

Moisture is another foe to effective refrigeration. Bacteria thrive on it, and it also favors heat conduction. In poor refrigerators moisture causes the inner lining to become corroded and covered with slime. Circulation of the air within a refrigerator is also important in maintaining low temperatures and in removing odors. Without it warm pockets of air may accumulate. Solid shelves of glass or galvanized iron hamper refrigeration. Shelves built of wire or other materials to permit free circulation are found in well-built refrigerators.

We all know how cold a poorly heated room without weather strips may become during bitter winter weather. The reverse situation is brought about by poorly constructed or carelessly fitted refrigerator doors. In fact, this defect may be responsible for from twenty to thirty percent of the total loss of refrigeration. The better types of refrigerators overcome this possibility with one or more gaskets fitted snugly in the door opening.

Many people cover ice in a refrigerator with newspapers. This is senseless. Covering the ice with anything at all prevents it from cooling the air inside the box. You get no refrigeration. It would be equally sensible to buy no ice at all.

CLEANLINESS in a refrigerator is vitally important, and any refrigerator so constructed that it cannot be cleaned easily is a source of danger. A few drops of milk or a morsel of meat in a crevice may cause microbe growth.

Efficiency is also promoted by placing each kind of food in its proper location. Milk, the children's food in which germs multiply rapidly, should be kept in the coldest compartment. Next to milk, butter, meat broths, and left-over soups require the coldest place. In fact, any milk dish should be kept where it is as cold as possible. Vegetables and fruits require the least refrigeration.

Americans, discriminating about plumbing, heating systems, automobiles, and other aids to comfort, convenience and sanitation, should spend a little time investigating their refrigerators.

Gus Explains a Broken Axle

How Your Car Turns a Corner in Safety and Why Every Automobile Requires Differential Gears in the Rear End

By

MARTIN BUNN

"Look at that rear wheel!" exclaimed Gus. "The axle is busted and it's coming out by the roots!" Gus and Joe shouted to warn the occupants of the car

"YOU might know we'd get stuck behind a bunch of cars on a hill like this," grumbled Gus Wilson as he shifted into low and prepared for the long grind up Smoke Hill.

It was Sunday, and the string of cars constantly passing in the other direction forced Gus and his partner Joe Clark to stay in line. They had left young Bill to tend the gas pump at their Model Garage while they drove to Windsor for dinner with Gus's sister and her family.

"This is a sure enough bad hill," said Joe, "but that's no excuse for crawling up it like a snail. What's the matter with those two cars right ahead? They're not even keeping up with the procession."

"Looks to me like the rear one is being towed," Gus observed. "The front car is filled with people and if it's trying to pull that extra load, I don't wonder they're going slow. We'll be lucky if they don't get stuck right in the middle of the hill. We're late enough for dinner as it is."

"I don't care much for soup anyway," grinned Joe.

"Humph!" Gus grunted, suddenly sitting up straight and gazing intently ahead. "We'll be lucky if we get there for dessert—look at that rear wheel! The axle is busted and it's coming out by the roots!"

As Joe looked the rear wheel of the car ahead moved out from under the mudguard till it was actually traveling into the path of the cars coming the other way.

GUS and Joe shouted to warn the occupants of the car ahead, but the roar of the racing motor in the front car drowned their voices. Passing cars veered out to avoid hitting the projecting wheel. Now the rear of the towed car settled with a crash on the concrete road; the jar snapped the tow rope and the first car, relieved of its burden, leaped ahead.

Gus, knowing what was about to happen, had lagged behind so he could avoid a collision. As he stopped his own car, a short and exceedingly fat man eased himself out of the disabled car, and right behind him came a skinny, freckle-faced youth.

"Pa!" croaked young freckle-face. "The wheel come off!"

"You don't say so!" puffed the fat man sarcastically. "Now, son, suppose you tell me how to get the blame thing on again if you're so confounded bright?"

By this time a string of cars were stalled behind Gus and curious drivers had stopped to look, thus tying up the cars proceeding down the hill.

"There goes the dessert, too," growled Gus. "I thought maybe we could sneak around and get on, but we might as well help this fat bonehead out of his trouble. Anybody got any tire chains?" he called out. "And jacks?"

Willing drivers offered them.

"NOW," Gus said, "I'm going to loop these chains around the brake drum with enough slack so I can hook the loop over the jack. Then when I get it as high as the jack will go, somebody stand by to shove the foot of one of those other jacks edgewise under the drum. That will hold it while I slack off and put something under this jack—the tire on the wheel that came off will do. Pushing the jack up to the top again ought to raise it high enough to let you get a jack under the axle in the regular way. You understand? Watch it now!"

Three men put their shoulders to the back of the car lest it start backing off the queer chain sling arrangement, and in no time at all Gus had the axle housing high enough to slip the shaft back in place.

"Where are you headed for?" asked Gus.

"Cooperstown," the fat man replied glumly. "I guess we'll have to walk it. No use trying to tow this wagon any more. The wheel'd just fall off again. Can you folks help me push it off the road and then maybe give us a lift to Cooperstown?"

"GET in our car," Gus offered. "We're going that way anyhow. We'll be back after dinner and pick you up if you want. Then we'll get the wrecking car and tow you to the Model Garage."

"Suits me," the fat one grunted as he heaved himself in beside Gus. "The bird that was towing me must have got cold feet. He didn't come back. What made that wheel come off, anyhow? There's a lot about this automobile business I don't get, somehow."

"You're in pretty good company," Gus laughed. "I suppose most auto owners on the road don't know what the differential gear is. As for why the axle broke—that was your fault. The wheel was loose on the axle. I guess you never tightened up the nut that holds the wheel on the tapered part of

(Continued on page 138)

Pointing a 10,000-pound Gun As Easily As *You* Might Point a Pistol—with the Help of SKF Bearings

TWENTY-TWO barks a minute from this dog of war that keeps watch over the heavens—each with a muzzle energy of 704-foot tons—each with a pull on the recoil mechanism of twenty-five thousand pounds!

And yet, two SKF Spherical Bearings located in the trunnions stand up under the crushing shock and wait for more! All the automobiles that you could cram on ten miles of the bumpiest highway in the country could not deliver that sort of shock to a bearing.

SKF Anti-Friction Bearings are used throughout our U. S. Army Anti-Aircraft Guns. Elevating and traversing shafts—connecting shafts for recording instruments—azimuth control—fuse setter—all operate on the highest priced bearings in the world.

For Uncle Sam, also, has found that "Nothing Is Apt to Cost So Much As a Bearing That Cost So Little."

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BALL AND ROLLER BEARINGS

U. S. Army Anti-Aircraft Gun in which 20 SKF Anti-Friction Bearings are used. It can be trained on a moving target either manually or automatically from a central station, in unison with other guns in the battery. The Sperry Torque Amplifiers used on these guns, are also SKF equipped.

"THE HIGHEST PRICED BEARING IN THE WORLD"

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Handy Kinks *for* Car Owners

Strong Start on Weak Battery—Other Useful Hints

EASY starting for the automobile motor depends on the proper mixture of gasoline and air and on a strong, hot spark, assuming of course that the mechanical condition of the motor is good.

By pulling out the choke knob you can be sure that there will be plenty of gasoline in the mixture, and by using the arrangement shown in Fig. 1 you can get a stronger and better spark than normal, even though the storage battery is not fully charged.

A fixed resistance coil is connected in the circuit in series with the spark coil to limit the amount of current that will flow in the coil and prevent it from burning out if you accidentally leave the ignition switch turned on when the motor is not running. The idea is to connect a stop light switch as shown in Fig. 1 so that when the plunger of the switch is pulled out the resistance coil will be short-circuited. The plunger of the stop light switch is connected by means of a piece

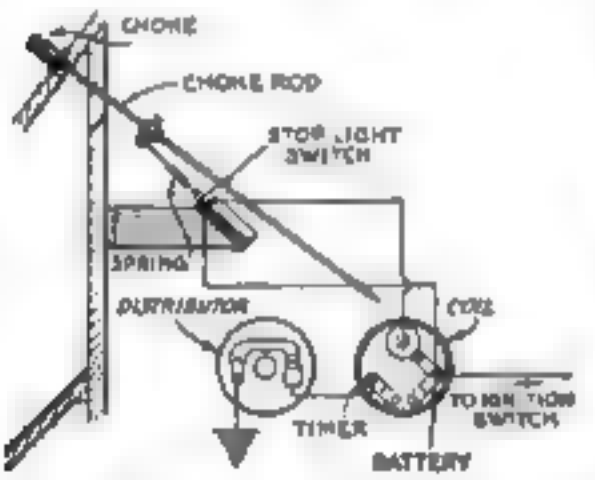


Fig. 1. Easy starting is insured by connecting a stop light switch with the choke button so that a resistance coil on the spark coil is short-circuited when the choke is out, giving a strong, hot spark

of wire and a spring to the choke rod, so that when you pull out the choke the resistance coil will be short-circuited and an abnormally large amount of current will flow through the spark coil, producing a fine spark even with the starting motor drawing a large amount of current from the battery. Pushing in the choke rod again after the motor starts restores the circuit to normal running condition.

Novel Ash Disposal

IF YOU have ever tried to knock the ashes from your cigarette or cigar by putting your hand out of the window and have had the ashes blown back into your face and all over the inside of the car, you will appreciate the ash disposal system detailed in Fig. 2. It consists, essentially, of a piece of one-inch flexible tubing such as is used in electric wiring. A flared nozzle is fastened to the top. Part of a small tin funnel will do nicely after the small end has been cut off. The lower end of the flexible tubing is passed through a hole in the floor boards and clamped by means of a sheet iron bracket with the open end pointing toward the rear of the car. The motion of the car will create a draft of air downward through the pipe to carry the ashes away.

It is desirable to locate the lower end of the pipe

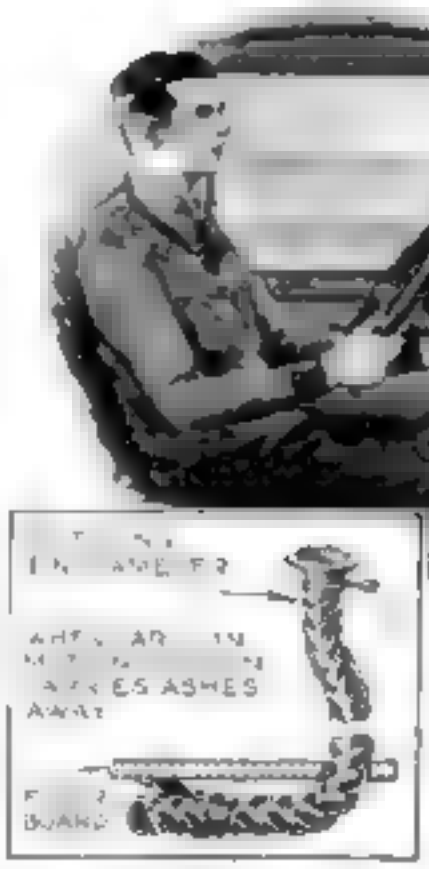


Fig. 2. A flexible tube placed as shown above will serve to receive cigarette and cigar ash problem

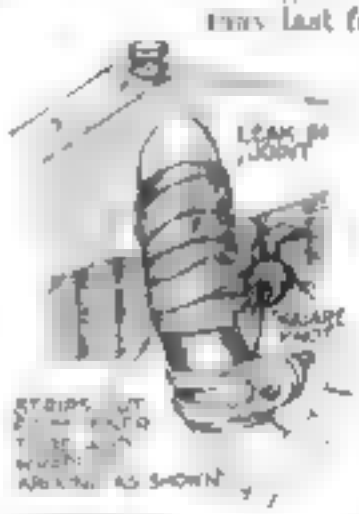


Fig. 3. Right. When the hose clamp screw on the hot strips a piece of old inner tube makes a water-tight emergency repair

Ten Dollars for an Idea!

HARRY W. PETERSON, of Seattle, Wash., wins the $10 prize this month with his suggestion for overcoming battery weakness, shown in Fig. 1. Each month Popular Science Monthly awards $10, in addition to customary space rates, for the best suggestion for motorists sent in by a reader. Other published contributions are paid for at the usual rates.

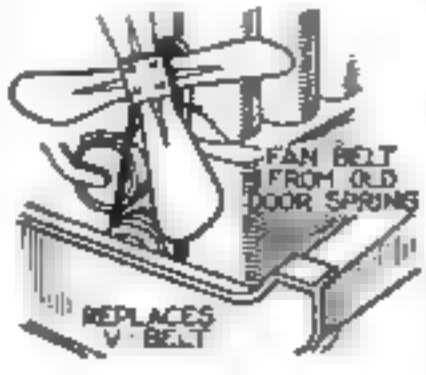


Fig. 4. An old screen door spring connected at the ends will operate the fan until you can replace a worn-out belt

to the ashes will not get on the storage battery. A couple of coats of any dark brushing lacquer makes the tubing inconspicuous.

Emergency Hose Repair

IF THE water-hose clamp-screw becomes stripped or the clamp cannot be tightened any more, you can make an emergency repair with a long strip of rubber cut from an old inner tube. Slide the clamp down out of the way and wind the strip of inner tube tight around the end of the hose and down onto the pipe. If the rubber is wound carefully and tight and the ends knotted as shown in Fig. 3, you will get a water-tight connection that will last for a long time.

Spring as Fan Belt

WHILE the only proper thing to do with a worn-out fan belt is to replace it with a new one, you can make a screen door spring serve in an emergency, as shown in Fig. 4. Two springs may be hooked together to take the place of a very long spring. Of course it is desirable to replace the spring belt with a regular leather belt at the earliest opportunity, as the spring belt will wear a groove in the pulley if used for any length of time and the groove will cause excessive wear on the new leather or composition rubber belt when you eventually fit it.

Round the Spring Edges

SOMETIMES springs will wear in such a way that the car will ride with a peculiar bumpy motion. This occurs when the shorter leaves are formed so that the edge gradually wears a section

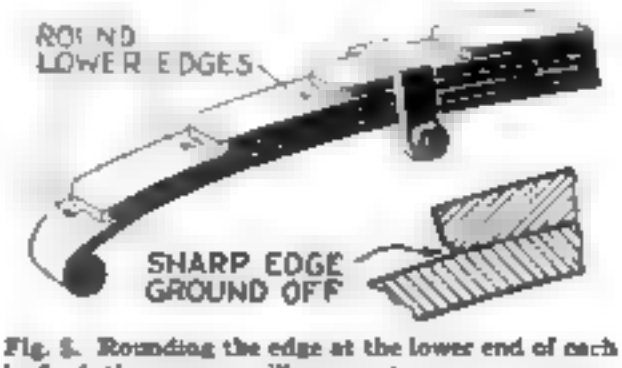


Fig. 5. Rounding the edge at the lower end of each leaf of the spring will prevent wearing away a depression in the leaf below and preserve smooth spring action even when riding over large bumps

of the leaf below it. When the wheel strikes a bump slightly larger than normal the edge of the spring is forced to ride up over the corner of the depression worn in the lower spring. The cure for this is to round the sharp edge at the lower end of each leaf as shown in Fig. 5.

Treat Your Plants Like Babies

Study Their Illnesses, Their Likes, and Their Dislikes, and from Your Garden You Should Get Rare Results in Flowers and Vegetables

By E. BADE

A mite (or which is the dominating order of the plants a nourishment and thus retards growth of the leaf but as punched off. Now, with all the encouragement the principal thing grows with sturdy and only a few days after eight or ten ready to open

IF YOU would have success with your garden the green plants which begin to flourish in May and June must be treated like babies. They have their troubles, their sicknesses, their likes and dislikes. Though a sick plant, like an ill baby, may live, only the healthy, sturdy flowers and vegetables will produce large flowers and fruits.

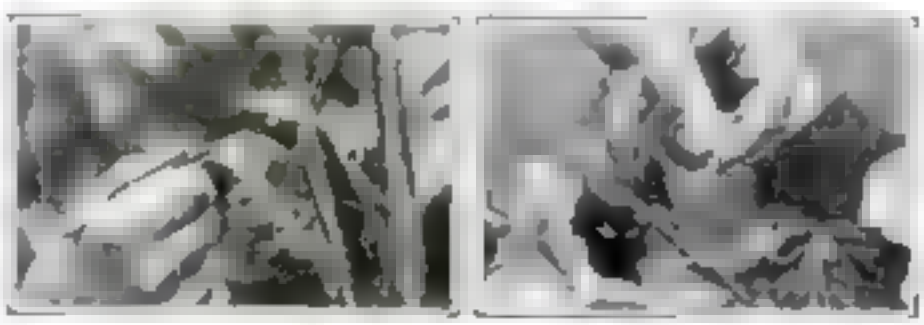
Watering, cultivating, weeding—these are your major cares. Judicious use of the pruning knife, and transplanting, too, may sometimes increase the yield. And many plants respond gratefully to a little liquid manure added during their time of fastest growth.

Wet your garden only when the rain clouds have completely fallen down on the job—when the soil is very dry, and powders easily. Then water it thoroughly. You may best turn rain-maker in the cool of early dusk, when the water will soak into the soil. The best time *not* to do it is in the middle of the day, when the sun is beating down; then the plants will turn out weaklings.

FLOWERS and vegetables alike demand that their soil be *loose* and *weed-less*. Air and moisture must penetrate to the roots. Garden plants will not tolerate crowding by weeds, nor robbery of the soil of its salts and moisture. After heavy rains or prolonged watering, break the crust of soil around the plants to keep it soft.

Beware of weed-killing chemicals, in general. They are so "good" that they will kill your plants too! It is true that a few chemicals are safe to use in very special cases. For instance, you can eradicate yellow dandelion heads from your lawn with a spray that will not harm the grass at all. Dissolve two pounds of iron sulphate in a gallon of water to make a dandelion-killing spray that will cover a spot about thirty feet square. Three applications of the preparation—in May, June, and early fall—are best.

Crowding the plants is as bad as letting them become overrun with weeds. Take advantage of their different space requirements. Radishes and lettuce, for instance, mature quickly, and need little room, you can grow them between rows of larger plants, such as tomatoes. When all luck spots your garden with vacant spaces where crops did not appear, fill the gaps with seedlings of the same crops—or with the seeds of other quick growing crops—timed so that they mature at the same season as the original planting.



Artificial fertilization to produce next year's seeds. Left: Cut the yellow stamens from a tomato flower and rub them on the pistil of the flower of another plant. Right: Remove the cucumber "male" flower from the vine and brush the yellow dust from it on the pistil of a "female" flower

Transplanting is a delicate operation made safe by intelligent treatment. Seedlings grown indoors are "hardened" by increasing daily periods of exposure to outside air for a few days before transfer to the garden. An hour before transplanting they are watered thoroughly, and again after they have been placed in their new home. Keep them shaded a few days to keep them from wilting, and they will flourish thenceforth. Care must be taken not to injure the roots, lest the plant die.

Some plants need a little pruning, training, or pinching. Tomatoes, for example, should be trained—tied to uprights—and side branches that develop no flowers should be pinched off early. Bigger tomatoes result.

YOU can make almost any plant produce larger fruit or blooms by letting only a few mature, pruning or pinching off the others. Flowers yield magnificent long-stemmed blossoms when side buds are pinched off. Vegetables, incidentally, thrive best when you pick their fruit just before it is ripe and allow it to ripen for several days in a cool place before use.

Your pruning knife is handy, too, in trimming ornamental hedges and bushes, in cutting off decaying twigs of shrubs and trees, and in lightening trees or bushes—taking care not to injure fruiting spurs of fruit trees nor the flower buds of shrubs.

There are also tricks to every trade, and in none more so than gardening. One of them, for instance, may help you to produce better vegetables.

Watch a commercial seed grower cutting the small yellow stamens from tomato flowers and rubbing the central pistils of other flowers with them, or tearing "male" cucumber flowers from the vine, removing the yellow floral envelope, and brushing the yellow dust lightly on the pistil of the "female" flower which he recognizes by the small cucumber at its base. He is preparing for a harvest of seeds. Insects usually accomplish this "fertilization," and on the farm are left to do it in their haphazard way. But the small gardener, if he is wise, selects one variety of a plant and by artificial fertilization "crosses" it with the best individuals of this type. Such a scheme assures him of vigorous seed for the next planting that will yield the finest crops.

One of the most common troubles of the apple tree is singed as seen at the left. When you are pruning your fruit trees do not remove these

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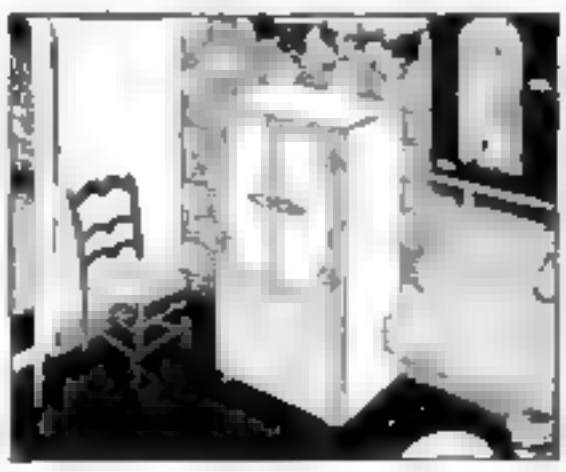

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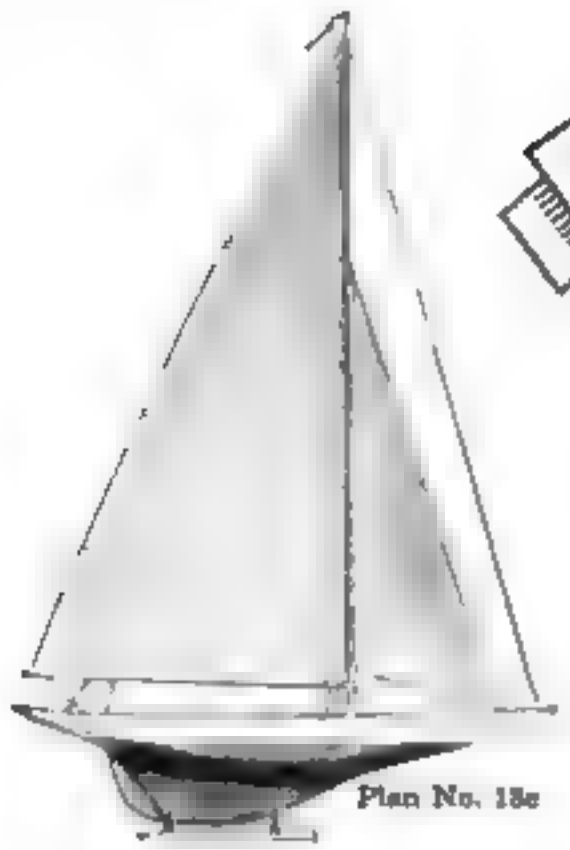
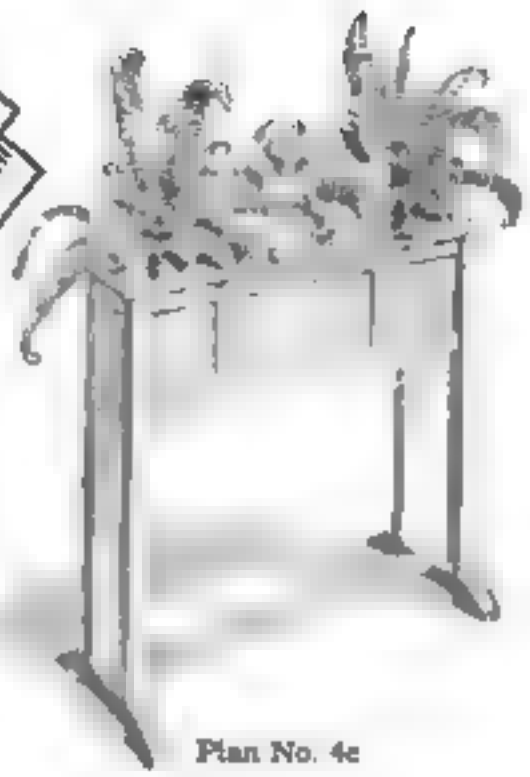


Plan No. 18e

MAKE THEM YOURSELF

Plan No. 1e



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Buy your Stanley Plans from your hardware dealer. If he cannot supply you, write to us. Send 10c for each plan and ask for a free catalog of Stanley Tools. Address The Stanley Works, New Britain, Conn.

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9e—Bird Houses
10e—Dog House
11e—Book Stand
12e—Smoking Cabinet
13e—Kitchen Cabinet
14e—Sewing Cabinet
15e—Cedar Chest
16e—End Table
17e—Tea Wagon
18e—Model Sailboat
19e—Combination Sail- and Row-boat
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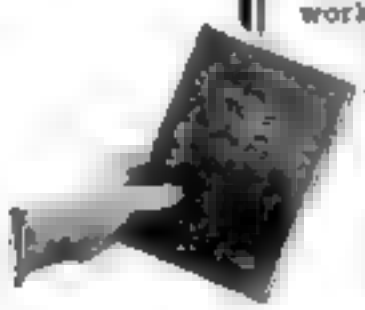

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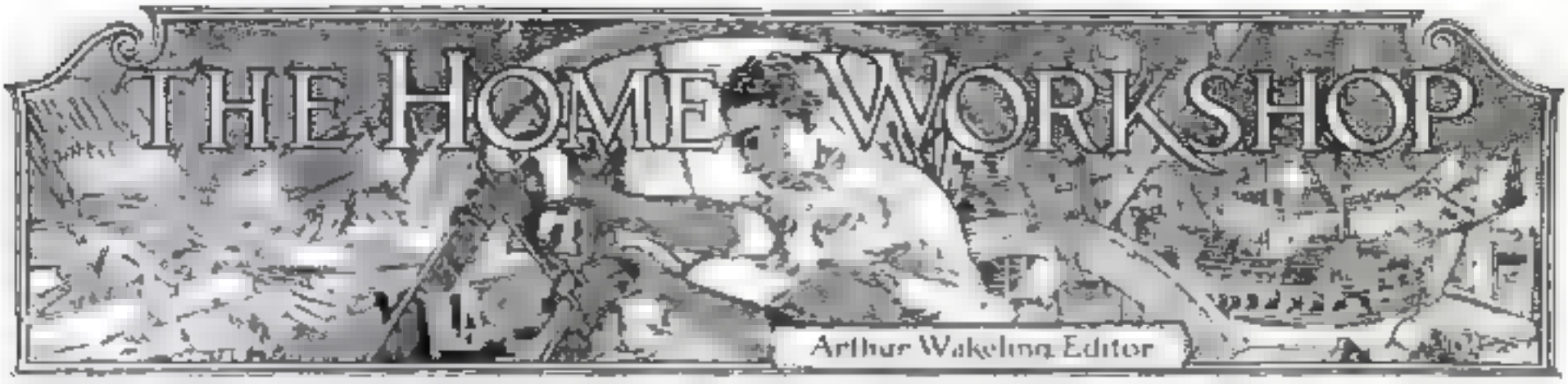


A Seaplane Model That Flies

It Rises from the Water to Give Amazing Performance in the Air —Has 30-in. Wing and Three Pontoons—Easy to Construct

By J. Danner Bunch and Avison F. Koch

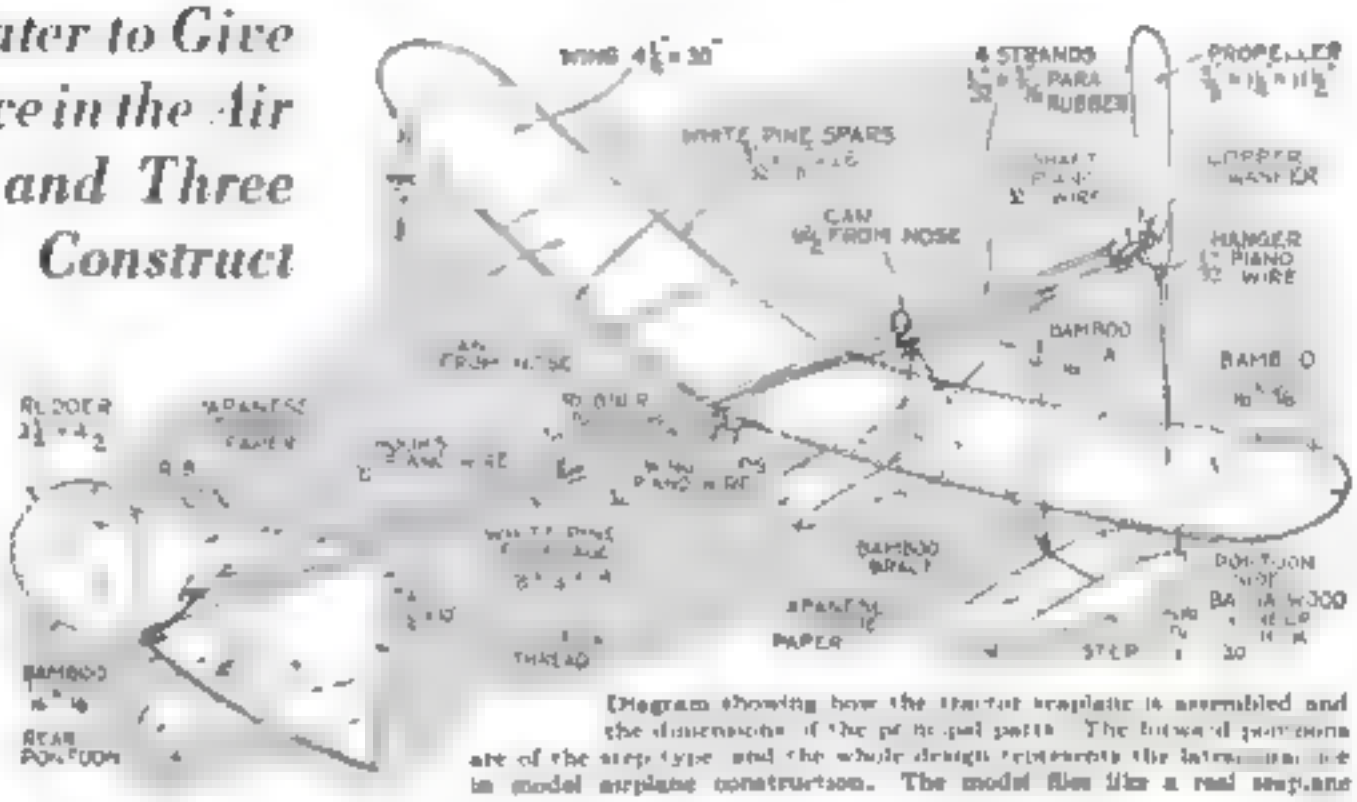


Diagram showing how the tractor seaplane is assembled and the dimensions of the principal parts. The forward pontoons are of the step type and the whole design represents the latest practice in model airplane construction. The model flies like a real seaplane

SKIMMING over the water on the steps of its forward pontoons and with its tail pontoon entirely out of the water, the tiny seaplane model speeds forward. Faster and faster it goes. Then, with a graceful skip, it rises into the air and flies like a real seaplane. With good luck, six feet to leave the water and a thousand feet of free flight!

There is no thrill like it in all the range of model flying. A well-designed seaplane model is, in the opinion of the writers, the most interesting type of all. Its flying characteristics reproduce in miniature the actual way in which a full size seaplane gets off the water and flies.

By constructing and experimenting with a model of the kind illustrated, you will not only enjoy the sport of flying it, but you will also make a start in the study of the aeronautics of the seaplane. The design incorporates the latest practice in model airplane construction, simplified in some respects to make the construction easier for the novice. The model has been carefully proportioned, the weight and resistance have been kept down, and the slowly revolving propeller is of large diameter so that the plane will remain aloft a long time. The model has a high center of gravity, a negative tail, and a rudder of generous size. The dihedral angle—upward slant—of the wing is so arranged that the model is inherently stable in the air.

You should study the drawings carefully and keep closely to the dimensions. If you do so, you will be able to produce a model that will rise quickly and fly high and far.

To make the work easier for you, a blueprint has been prepared showing the pontoons and many of the details full size. These working drawings, because of their clearness and number, can be followed better than the necessarily smaller illustrations which accompany this article. Unless you are a thoroughly experienced model maker, it will be advisable to send for the blueprint, using the coupon on page 99. It is No. 87 in the list.

For tools you will need pliers, a sharp knife, a razor blade, a small plane, and shears. Materials needed are: 1 or 2 oz. of the ambroid variety of cement or glue, which is waterproof, or its equivalent; 4 strips of split bamboo [illegible] by ⅛ by ¼ by 12 in.; 1 pc. balsa (or scant ⅛-in. white pine) veneer 1/32 by 6 by 12 in.; 2 pcs. white pine ⅛ by ⅛ by 20 in. and 1 pc. ¾ by ¾ by 24 in., all three with a slight grain showing to indicate stiffness; 1 pc. soft white pine ⅜ by 1¼ by 12 in.; 3 ft. of ⅛ in. diameter piano wire; 1 pc. Japanese tissue paper large enough to cover the wing, tail, and pontoon surfaces; 1 spool of silk thread, 1 copper washer with a ⅛-in. center hole, 4

The model takes to the air. Model airplane enthusiasts are agreed that their hobby holds no greater thrill than the flying of a well-designed seaplane

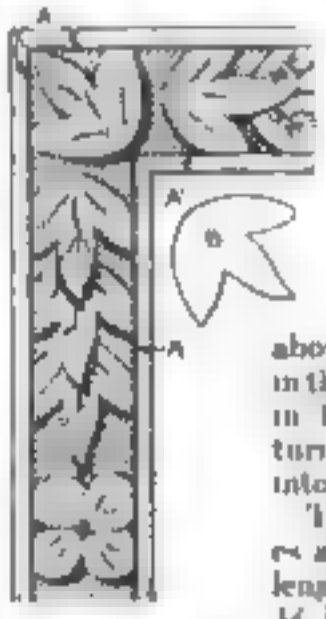
(Continued on page 111)

Simple Workbench *Kinks*

Wood Carving You Can Do Quickly—A Tool Rack —Planing Strips for Models—Handmade Hinges

BY A surprisingly simple method, folding screen frames and other pieces of homemade furniture and novelties can be decorated with artistic wood carving. Choose a soft, clear, straight-grained wood such as red cedar, and, if you wish to make a three-fold screen with frames such as those illustrated in Fig. 1, buy ¾ by 1¾ in. strips—regular screen stock. After the frames have been made, lay one on a bench or any firm support and place a cushioning piece of corrugated pasteboard beneath the spot you are to begin carving.

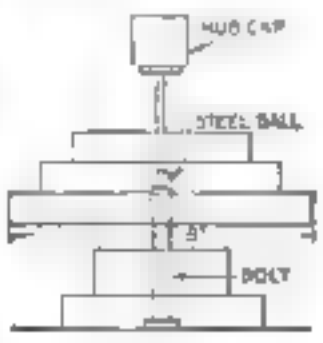
With a knife or any tool that will scratch the wood ⅛ in. deep, mark the border lines *A*, Fig. 2. Next prepare a cardboard pattern such as *B*, which may be any appropriate leaf or flower form, and use it to mark the design on the frame.



Cut around the edges of the leaves or flowers, except where they overlap, with a ¼-in. chisel, driving it in perpendicularly about ¼ in. with a mallet or the flat of your hammer. To trace the veins of the leaves or the flower markings, use a small dull screw driver about ⅛ in. wide and hammer it lightly into the wood. Then chisel out the background (the shaded areas in Fig. 2) without attempting to smooth the recesses, they look better if left a little rough, just as the leaf edges are more artistic when the cuttings are slightly zigzag. Brush out the chips with a whisk broom, and keep a can of liquid glue handy to replace any small pieces that may break across the design.

Battering down the wood slightly along the lines marked C with a blunt tool will give an overlapping effect. For this I used the ¾ in. square shank of an old drill, held slantwise.—CHARLES F. MILLS.

FOR the tinker who works in the kitchen of an evening as well as for the home mechanic who has a well-equipped shop, a turntable tool rack of the type shown in Fig. 3 will prove a timesaving accessory. It can be carried easily from place to place.



An old lollipop stand found in a grocer's junk pile was used for the turntable, but three disks of wood sawed from a ¾ or 1¼ in. board

Fig. 1. Carving threefold screen frames
Fig. 2 (at left). The type of carving used

and glued together as in Fig. 4 would serve as well. Holes are drilled as required to receive the various tools.

The rack turns upon a ½-in. bolt about 4½ in. long, which is a driving fit in the wooden base. A ⅛-in. hole is drilled in the center of the underside of the turntable, and a ½-in. steel ball is dropped into it before the rack is mounted.

The hub cap, which holds small wrenches and similar tools, is riveted to a 4-in. length of iron rod (or heavy wire nail) ¼ in. in diameter, one end of which is first filed down to form a shoulder upon which the cap can rest. A hole is drilled in the top of the turntable to receive the other end.—E. T.

IN MAKING blocks for the Chinese cross or block puzzles of similar character, or indeed, in preparing accurately

Fig. 3. One hundred tools within a cubic foot
Fig. 4 (at left). How the tool rack is made

dimensioned strips of wood for model making or any other purpose, the planing guide illustrated in Fig. 5 will be found convenient. It is well to have several of the devices for strips of different thicknesses.

An iron jack plane such as the amateur is likely to have is about 2⅜ in. wide, 15 in. long, with a blade 2 in. wide. Blocks for puzzles are usually ½ in. square and vary in length. For this size plane and blocks we cut out a strip of board ¾ by 2½ by 15 in. and nail on one end a stop ¾ by 1 by 2 in.; this forms the bottom

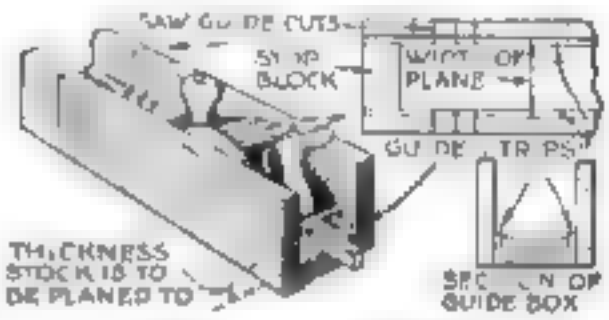


Fig. 5. Planing and sawing guide for preparing small strips and blocks with accuracy

for the plane guide. Two pieces for the sides are cut out of ¾- or ¼-in. wood, 2½ by 15 in. Along these sides and ¼ in. above the bottom edge are nailed two strips ¾ by ¾ by 15 in. The two sides with strips attached are now nailed to the bottom so as to make a box in which the plane can slide easily ¼ in. above the bottom. Right angle cuts are sawed 1½, 2, and 3 in. from the edge of the end stop for sawing off blocks of those lengths.

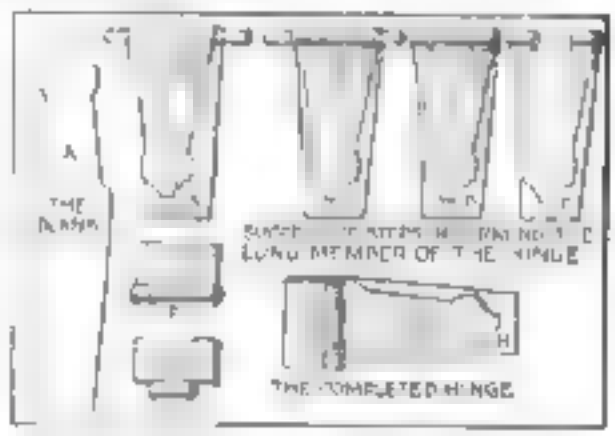


Fig. 6. Steps in making a decorative hinge from copper or brass without special tools

The plane blade should be sharp, perfectly horizontal, and set for a fine cut.—ARTHUR L. SMITH.

A PRACTICAL handmade hinge, which may be adapted to many kinds of craft work, can be made as shown in Fig. 6. First prepare a cardboard pattern like *A* and trace around it on the metal—preferably brass or copper—with a pencil. Cut the piece out with tin snips, hack saw, or cold chisel, as the thickness of the metal may (Continued on page 84)

Fig. 1. Most successful of the many varieties of surf boards used on the breakers of southern California is this light model made of plywood

Surf Sleds and Boards

Simple Ways to Build Them—One Type Is Only a Piece of Plywood, yet It Gives Thrilling Sport

By Hi Sibley

THERE used to be a tradition that no one but a native Hawaiian could ride a surf board. Young America, expert in the sports of all nations, soon exploded that myth. Now nearly every beach on the Atlantic and Pacific Coasts, as well as on the Great Lakes, has its devotees, some of whom have developed a fine skill.

Persistence and enthusiasm are required to master this exciting sport, it is a matter of catching the right roller at the right time—of climbing aboard just as the comber is going over. One can learn by practice better than by being told how to do it, but to start with one must have a suitable surf board or surf sled. A sled requires a little more work to construct, but it will give the less skilled or less daring bather a sure-fire ride on the crest of the foam. Both types are illustrated.

Surf boards are made in a large variety of styles to suit individual tastes, but the one which has proved the most successful on the breakers of southern California is the light plywood model shown in Fig. 1. This illustrates a boy's size—about 4½ ft. long. A drawing at the bottom of Fig. 3 shows how to make its adult prototype.

A plywood board is desirable because of its lightness and the fact that it is not likely to split or warp. It may be purchased from any cabinet-maker and from many lumber yards. A three-layer piece about ¼ in. thick is satisfactory, although a thicker piece of five-ply wood will make a more substantial board.

Saw the outlines as shown with a good keyhole or turning saw. A sharp saw with comparatively fine teeth is to be preferred, as there will be less likelihood of tearing the wood. The hand slot is made by boring two ¾-in. holes about 5 in. apart and sawing out between them. The slot is only for convenience in carrying the board, it is not used in the surf. The rider grips the sides of the board where he can shift his grip or let it go entirely if disaster looms.

IT IS highly important to round off all sharp corners and edges to prevent cuts and bruises while in the turbulent surf. You must also give the edges several coats of spar varnish so there will be no possibility of the water's soaking in between the layers and loosening them.

As the plywood usually has a beautiful grain, a natural finish with spar varnish produces the most attractive appearance.

Fig. 2. The surf sled can be used in any sea not too dangerous for ordinary bathing. The rider holds himself by the handgrips or lies flat on the deck. In Fig. 3 is shown a slightly improved design

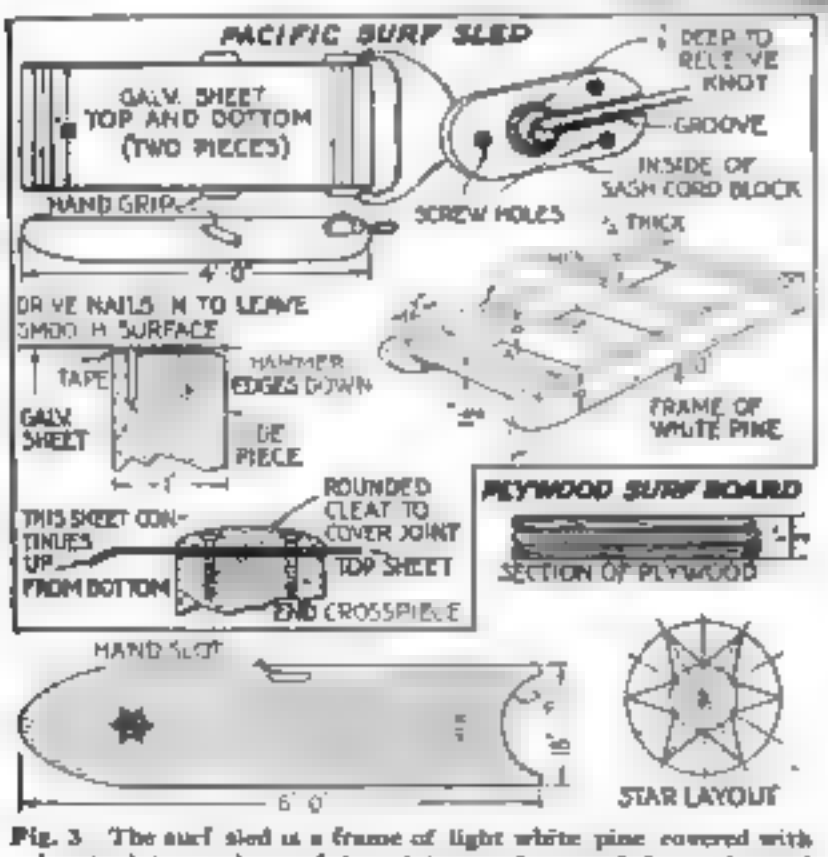


Fig. 3. The surf sled is a frame of light white pine covered with galvanized iron; the surf board is merely sawed from plywood

First, however paint in your star at the forward end. Brilliant vermilion, or bright green with an outline of gold, is effective. On one board the writer made a gold-leaf star with green border. It is a good idea to put your initials and address at the lower end of the board, for anything as much in demand as a surf board has a tendency to wander from the home strand.

Because the lower end is cut to fit the body the bather is able to walk out facing the surf and looking for an accommodating wave (Fig. 4). When it comes he quickly swings the light board around and climbs aboard for a swift and merry trip.

Take great care that the nose of the board is always tilted up. If it goes down and strikes the sand, with a big breaker behind, painful injury may result.

With a surf sled such as illustrated in Fig. 2 and the drawings in the upper part of Fig. 3, the rankest amateur is guaranteed a successful, hair-raising trip, provided he once gets it out to the starting point. Being sufficiently buoyant to support a heavy adult, the sled calls for little skill except in the matter of getting under way and has a great advantage in that it can be used successfully in much lighter surf than the surf board. It even can be used as a float or raft in calm weather and will always be in demand.

This type of sled is fairly light for a grown person to manage, but it is not the thing for a youngster to tackle, except in moderate seas, because of the tremendous force with which waves may strike it broadside. Note that all edges and corners are rounded, so that if one has a spill and is struck by his mount, it will not leave any appreciable dents. The vital importance of removing all protruding angles was learned after several beginners had become conspicuously bruised by screw eyes used in our first model.

THE proper way to maneuver the surf sled is to walk into the surf at right angles, towing the sled behind you by the sash cord provided for that purpose. It will slide over the oncoming breakers easily if the stern is lifted slightly.

Use light white pine for the framework and fasten it with flat-head wood screws, well countersunk. The

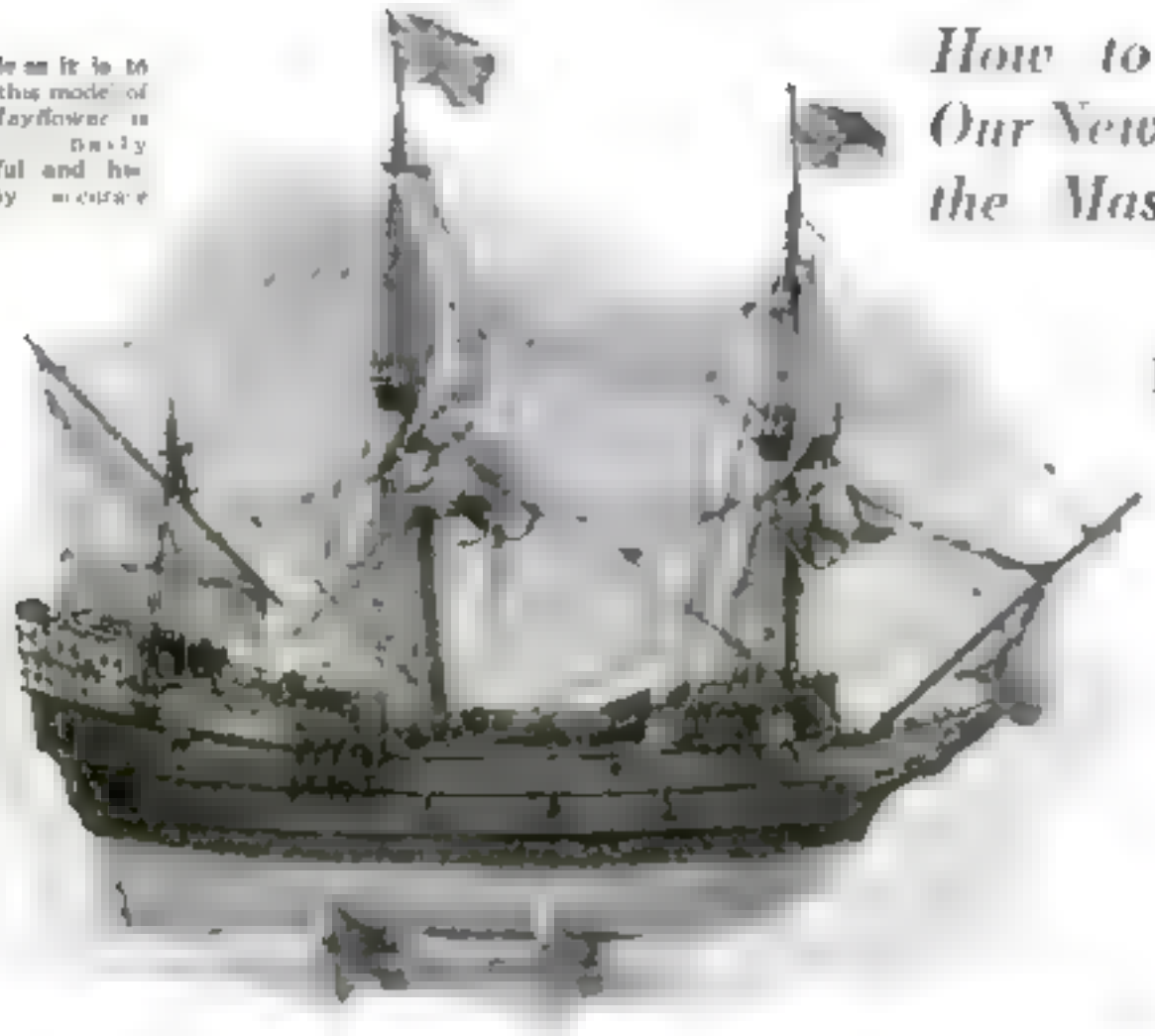
(Continued on page 96)

Fig. 4. The light plywood surf board is easy to handle. The lower end is cut so as to fit the body. The bather takes this position when walking out into the surf

Rigging the *Mayflower*

How to Prepare the Spars for Our New Ship Model—Setting Up the Masts—The Third Article

By
E. Armitage McCann



Simple as it is to build, this model of the *Mayflower* is extremely beautiful and historically accurate

THOSE who are building our model of the *Mayflower* and have followed the instructions given in the April and May issues will realize by this time that she is becoming a beautiful little ship and will be eager to fit her with spars, rigging, and sails.

Any who have missed the preceding installments but would like to build the model will find it no great task to do so. The hull and deck furnishings previously described can be constructed easily from the full size drawings contained in Blueprints Nos. 83, 84 and 85, which may be obtained from the Blueprint Service Department of Popular Science Monthly, 250 Fourth Avenue, New York, for 75 cents (see page 90). They show every detail of the construction and rigging and contain a complete bill of materials. The April and May issues of the magazine, with the complete instructions, may also be had at 25 cents each while the supply lasts.

As previously explained, little is known about the *Mayflower* except her size. All that has been learned about ships of her period, however, has been carefully collected, and this model is the embodiment of that research. It is thus believed that one of her sailors, although perhaps not recognizing the model as his own ship, would acknowledge it to be a correct vessel of that time.

The spars should be made next, so that the varnish on them can become dry while we are getting ready to fit them.

They can be made from straight-grained dowel sticks. The masts and bowsprit taper to about one quarter less than their full diameter at the upper ends and the yards to about one half at each end, with a slight shoulder at the yardarms (where the braces fit on). The heads of the masts, from the lower edges of the trestletrees to the ends, will be square, their extreme ends having a slightly smaller square to take the caps. Only the fore and main lowermasts will have their sides flattened below the trestletrees to take the cheeks. These and the following details of construction are shown full size on Blueprints Nos. 84 and 85, to which reference should be made.

If the hull is hollow, the lowermasts will have to be long enough to reach to the bottom and should have a short nail point sticking out of them to retain their ends in position; if the hull is solid, they should be set 1 in. into it.

The dimensions of the spars in inches are as follows. The length of the lowermasts is measured from the deck.

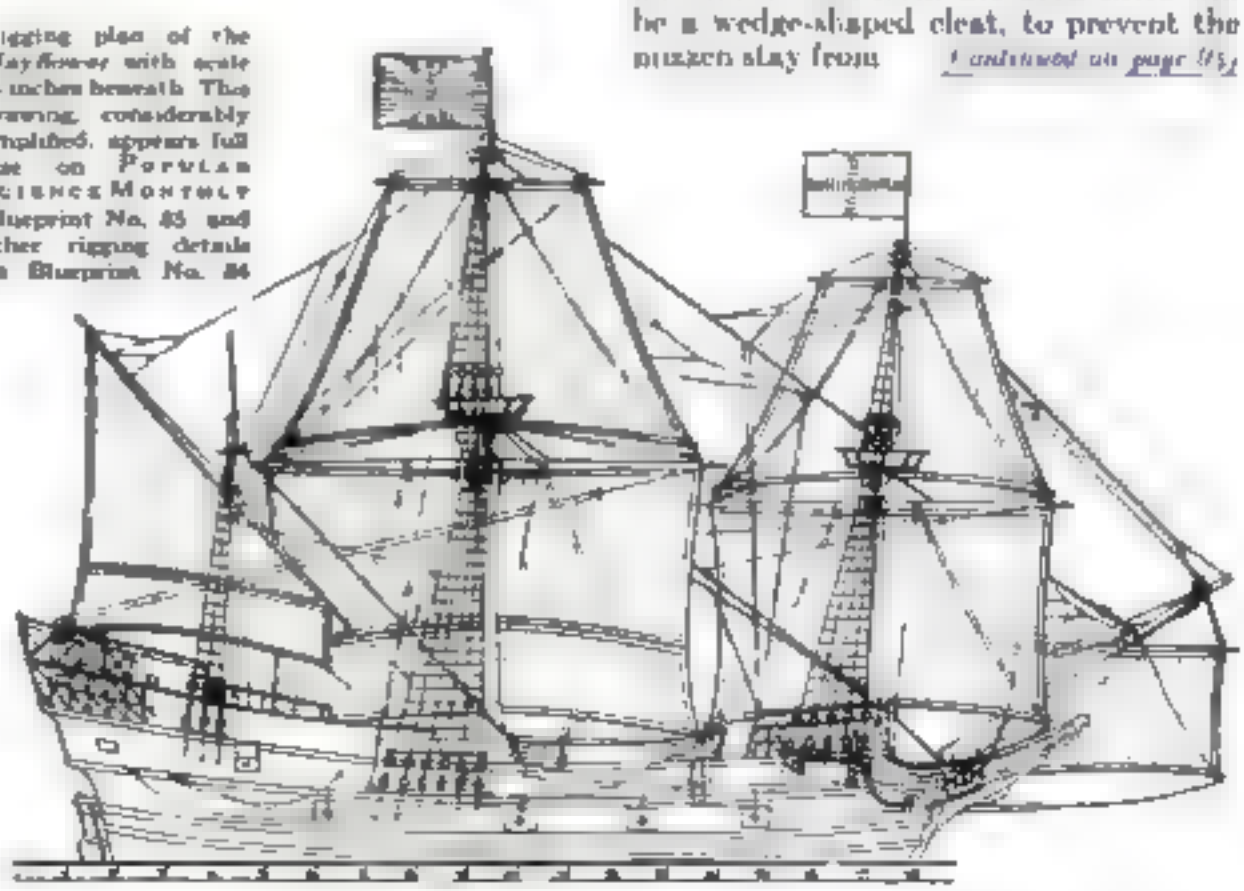
Mainmast, $\frac{7}{16}$ by $8\frac{1}{2}$, foremast, $\frac{3}{4}$ by 6, mizzenmast, $\frac{5}{16}$ by 5; main topmast, $\frac{3}{4}$ by 6; fore topmast, $\frac{1}{2}$ by $4\frac{1}{2}$, bowsprit, $\frac{3}{4}$ by $7\frac{3}{8}$; flagpoles, $\frac{1}{8}$ by $2\frac{1}{4}$ or $2\frac{1}{2}$; main yard, $\frac{5}{8}$ by $8\frac{1}{4}$, fore yard, $\frac{5}{8}$ by $7\frac{1}{2}$, mizzen yard, $\frac{1}{2}$ by $5\frac{1}{2}$; main-topsail yard, $\frac{1}{2}$ by $4\frac{1}{2}$; fore-topsail yard, $\frac{5}{8}$ by $3\frac{1}{2}$; spritsail yard, $\frac{3}{4}$ by $5\frac{1}{4}$.

All the spars should be stained and varnished a reddish brown and should have as many as possible of their fittings in place before they are erected.

On the lowermasts glue and nail the cheeks and bore sizable holes through them to take the ties of the halyards. To be fastened above these are the crosstrees, which consist of two fore-and-aft trestletrees with the three crosstrees half lapped into them. The trestletrees and two after crosstrees fit tightly the square part of the masthead, and the forward crosstree lies sufficiently apart to allow the heel of the topmast to pass. It is better in a model to have them so close that the heel of the topmast has to be slightly squared to fit through them, with a fid (piece of wire) through the heel, to rest on the trestletrees.

Both fore- and mainmast have two belaying cleats fastened on either side of them about $\frac{3}{4}$ in. from the deck. On the mainmast 1 in. from the deck there will be a wedge-shaped cleat, to prevent the mizzen stay from

(continued on page 115)



Rigging plan of the *Mayflower* with scale in inches beneath. This drawing, considerably simplified, appears full size on Popular Science Monthly Blueprint No. 85 and other rigging details on Blueprint No. 84

This is the Clayton & Lambert No. 70 fire-pot with tinner's head. Produces a working flame in ninety seconds. Flame controlled as easily as a lamp. The burner orifice cannot be enlarged by tightening the needle valve. No chance of ruining the fire-pot that way—that's an exclusive C & L feature. Will heat a pair of soldering coppers and melt a pot of metal at the same time.

Ready for use in a *minute and a half!* —and that's only part of the story

YOU'RE going to get a real kick out of it—the first time you light up one of these new Clayton & Lambert fire-pots. No hanging around waiting for it to warm up—ready for business in a minute and a half in any weather. Cold and wind make no difference. Clayton & Lambert took care of that in designing these new fire-pots.

And after you get that hot, blue flame you can control it as easily as a lamp. Turn it up or down, just where you want it. *There's* a chance to save a lot of fuel.

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Either of the two Clayton & Lambert fire-pots shown on this page will burn at full capacity for six hours on a single filling, which means you can stay right with your job instead of chasing up more fuel and letting your metal go cold.

Most hardware and supply stores sell these Clayton & Lambert fire-pots. You can identify them by the bright, red band around the base of the fuel tank. If they don't have them in stock they can get them for you quickly. And you'll certainly be well repaid for being particular and asking for them by name. For the performance of Clayton & Lambert products has made this company the largest producer of fire-pots and blow-torches in the world, giving you quality articles at the savings permitted by quantity production.

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How to Paint a *Breakfast* Set

Five Ways to Finish Tables and Chairs in Bright, Cheerful Colors -The Use of Stencils and Art Transfers

By BERTON ELLIOT

BREAKFAST room furniture is sold unpainted today in almost every furniture store, and countless families are buying complete five-piece sets and decorating them at home. There are also many who buy simply a table, to be used with odd chairs already on hand, or who desire to make use of an old kitchen table and unmatched chairs. Then, too, the home craftsman can often buy an old table or set of chairs second hand

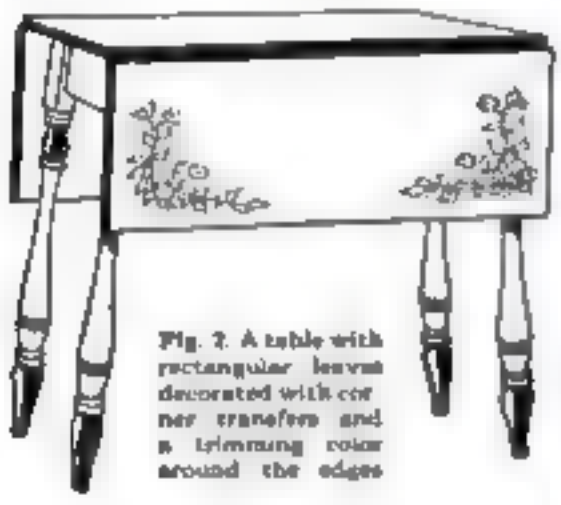

Fig. 2. A table with rectangular leaves decorated with corner transfers and a trimming color around the edges

and refinish them himself at considerably less cost, in a shorter time, and with more satisfaction than he can build and paint a new set of furniture.

The beauty of breakfast sets depends largely upon their color treatment. As

Fig. 3. Half-round table leaves with a stencil transfer or a stenciled design look very well

the breakfast room is a chummy place where the family gathers, breakfast sets should avoid every semblance of formality and be painted in bright, refreshing colors. Effective color schemes depend upon both the proper combination of colors and the right proportion and location of each color.

Here are combinations that go well together, any of which could be used in any one of the five schemes of decoration illustrated: Lettuce green, trimmed with gold, Chinese red, trimmed with black; twilight blue, trimmed with orange; French gray, trimmed with turquoise blue; stem green, trimmed with white; French gray, trimmed with orange.

Fig. 1. Mr. Elliot is shown demonstrating where to apply the trim color on the turnings of a chair

As to the proportions of each one color should definitely predominate. The location depends largely upon turnings and ornamental work that happen to be on the piece (Fig. 1). Careful thought should always be given to the "spotting" of trim color, as this is an important factor. Try to visualize in advance how the piece will look when it is finished.

A group of odd pieces may be developed into a harmonious set as shown in Fig. 4.

Fig. 4. How a group of odd pieces may be developed into a pleasing and harmonious set

A table with half-round leaves, Fig. 3, looks especially well when the leaves are dropped, but is not so practicable when more than two are to be seated, as the rounding corners take away considerable space. It may be prettily decorated with a transfer design in the center of the drop leaves and stripings on the legs. The trim color can follow edge if desired.

One method of decorating a square-cornered drop-leaf table is shown in Fig. 2.

A table of octagonal shape, Fig. 6, may have a border design going around each leaf as a unit. A transfer design may be centered in the border as

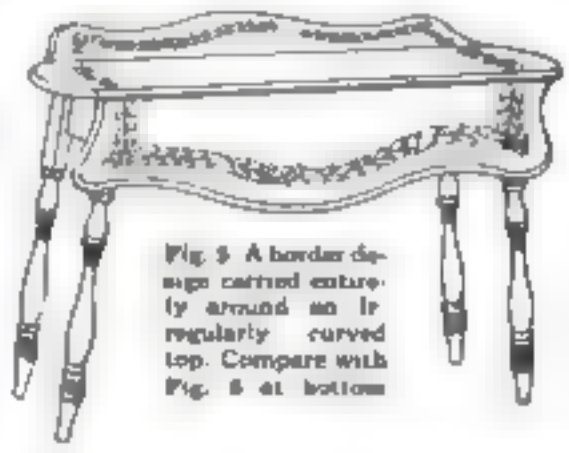

Fig. 5. A border design carried entirely around an irregularly curved top. Compare with Fig. 6 at bottom

shown, or placed in the middle of the drop leaf.

Figure 5 is typical of many fancy drop-leaf table designs available. It can be treated as shown or stripped.

Borders near around any table may be produced by transfer strips, which may be obtained in lengths especially for this purpose, or by stenciling.

As to the materials to use, either brushing lacquer or enamel is especially suitable for this purpose.

In the application of the finish, the table tops and the chair seats being the largest and conspicuous surfaces, should be done last. As a rule they ought to have one more coat than the rest of the surface.

If *lacquer* is used, three coats for the table top and chair seats and two coats for the remainder will ordinarily produce a first-class finish, although sometimes a good job may be produced with two coats throughout; on the other hand, four coats may sometimes be necessary on the large flat surfaces. The surface should be sandpapered thoroughly before starting to apply lacquer, but not between coats.

If *enamel* is used, the first coat or coats should be flat undercoater, followed by one or two coats of enamel. Sandpaper lightly between coats. The use of transfers was described in July, 1927, POPULAR SCIENCE MONTHLY.

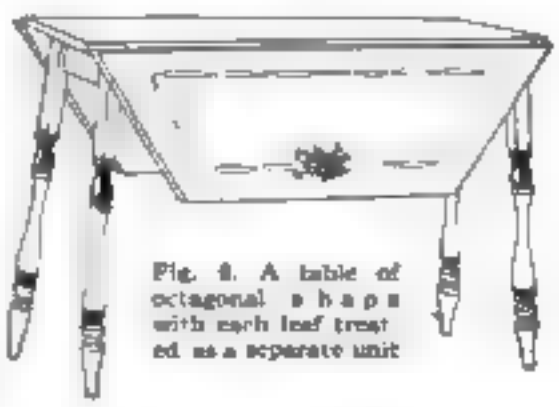

Fig. 6. A table of octagonal shape with each leaf treated as a separate unit

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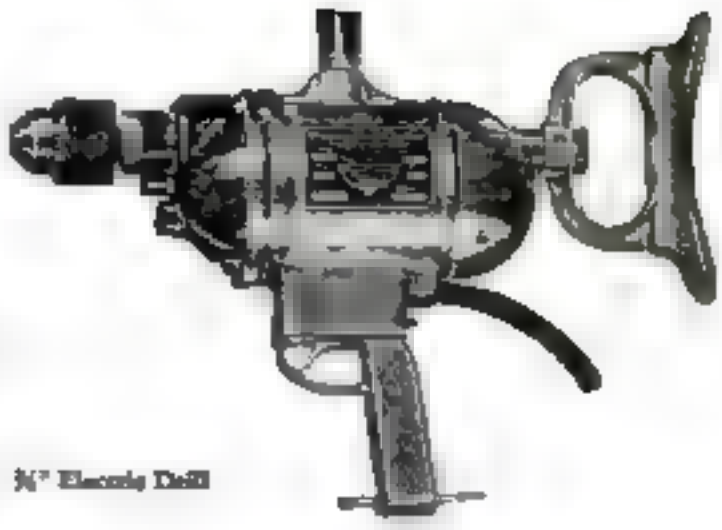

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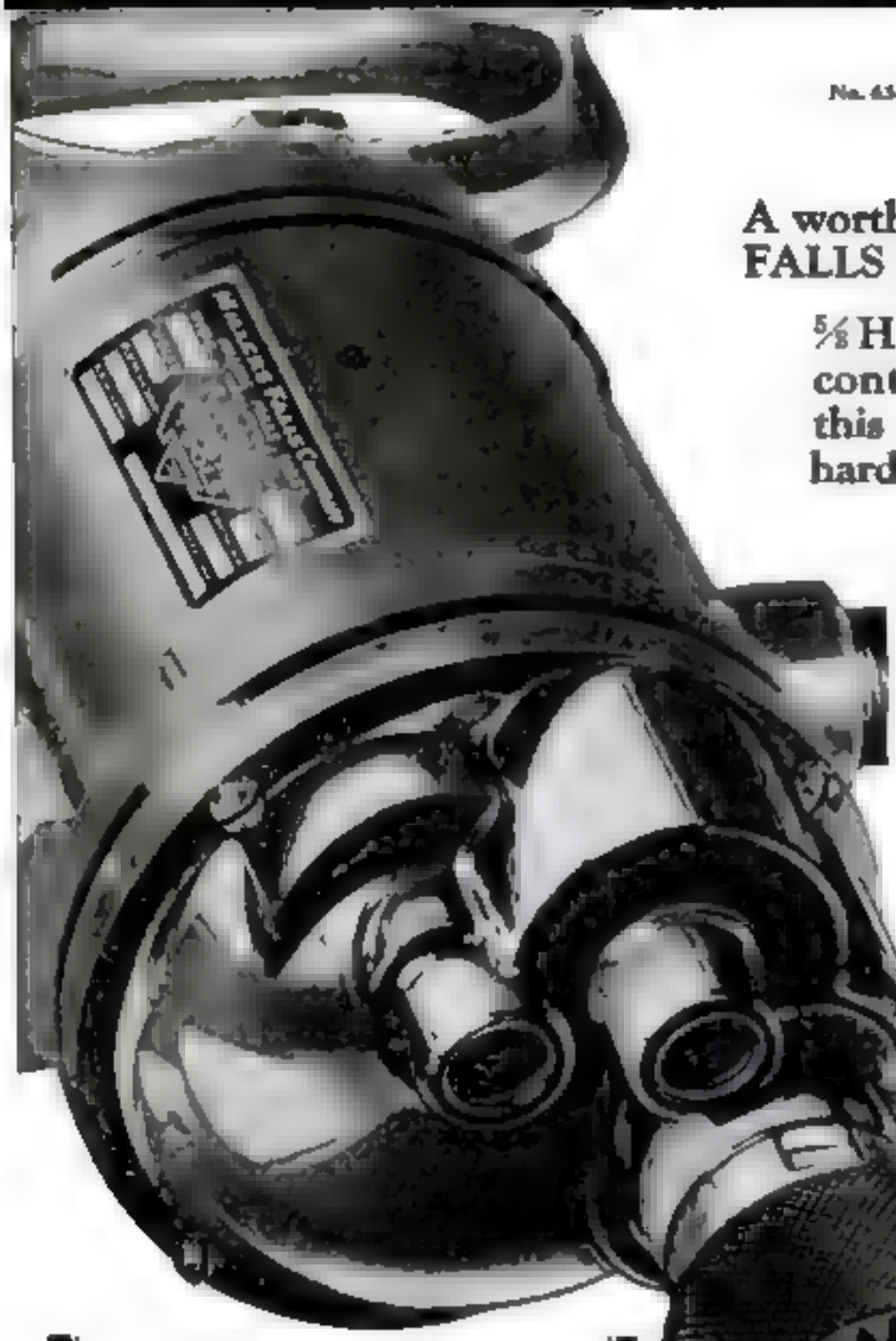

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Hints on Using Portable Tools

How They Lighten Work in the Shop if Utilized to Full Capacity—Keeping Them in Order

By H. L. WHEELER

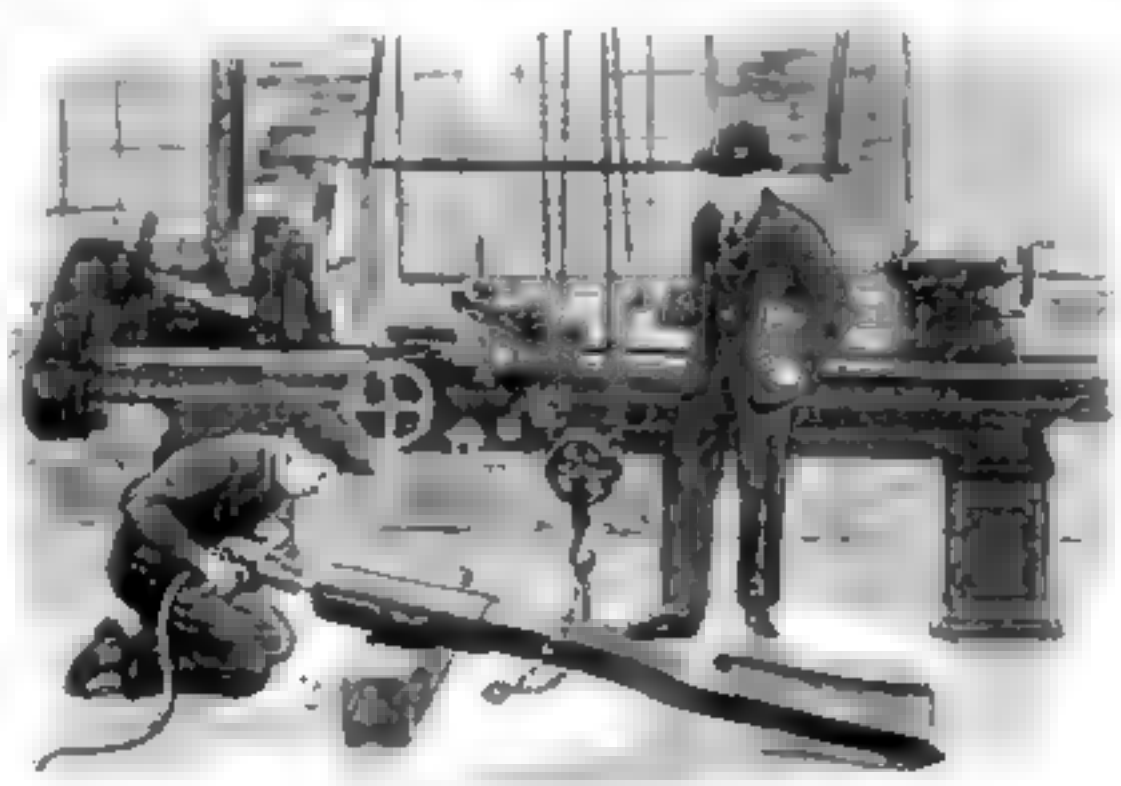
"SHALL we take the tool to the job, or take the job to the tool?" is a question often asked in machine shops, now that portable tools have come into general use in all lines of industry. The task of transferring a heavy job to some machine for a simple operation may often be saved by using a portable drill, grinder, tapper, buffer or other motor-driven tool.

Most mechanics have at least a speaking acquaintance with portable tools, and some workmen are very expert in operating them. It is possible, however, for everyone to discover new uses for these little machines. My main idea in this article is to stimulate thought in this direction with a view of lightening the labor of machine shop work.

I have a keen recollection of an awkward job that once came into the shop with a red rush order attached. It was a well drill-bit forging weighing about 600 lbs. and of unusual irregularity. This huge chunk of steel had to be turned and threaded on the shank end.

Naturally, the first thing that had to be done was to drill and ream a center in the shank end. The idea was to hold the heavy wedge-shaped end in the lathe chuck and let the small end run on the tailstock center. At first thought, the operation appeared to be a simple matter. And it was—with a portable drill.

By blocking the end of the forging on the floor as illustrated, the machinist located the center in the usual way and marked it with a center punch. A center reamer and the drill did the rest. Altogether it was about a half-hour job, while without the portable it might have taken four or five hours, for the forging was 6 ft. long and so rough and irregular that it would have been difficult to manage in either lathe or drill press.



The huge well bit forging was blocked up on the floor so that a center could be drilled and reamed in the shank with a portable electric drill

How often have you taken a big shaft out of a lathe to drill one or two holes on a drill press some distance away, and then lugged it back again to the lathe to do some more work upon it? Perhaps you spent some time in hunting for bolts and straps to hold it on the drill press; you had to go to the crib for a drill; you had to adjust the machine; finally, you had to move the shaft again. Now, did the shop have a portable drill? Would it have been possible for you to have drilled the hole without removing it from the lathe? If so, you would have saved your time and labor.

Motor drills are by no means intended for, or limited to, the drilling of an occasional hole. They are good production tools. Drilling structural parts and sheet metal work is only one of a thousand ways they are brought into use.

One or more drills can be suspended from a convenient point overhead with a cable or rope, a stiff coil spring being placed as a lifter or shock absorber between the motor and cable. This arrangement relieves the operator of the weight of the tool and gives it much better balance. Sheet metal work can be drilled on the floor, bench, or suitable tables. Structural parts, consisting of various shapes of structural iron, heavy castings and the like, may rest on wooden horses, with the drill motor hung conveniently overhead or attached to the trolley of a floor crane or an I-beam so that it can be moved over a wide area.

Clamped in a wooden cradle as shown on page 101, or gripped in a bench vise, the motor drill may be used for polishing, buffing, or light grinding by providing appropriate attachments held in the drill chuck. A small grooved pulley on the drill spindle converts it into a motor for driving small machines for experimental or test purposes.

Have you ever operated a milling machine with a large face mill that screws onto the spindle? After running the cutter until it was becoming dull, did you, perhaps, try to grind it on the one little light cutter (*Continued on page 101*)

MANY timesaving shop ideas are contained in the continuation of the Better Shop Methods Department, to be found on pages 86 and 101 to 103.

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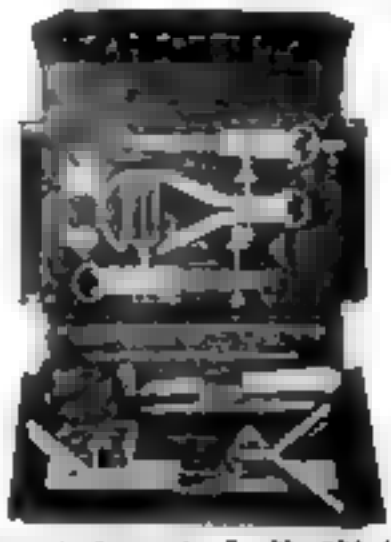

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Small Planer Does Heavy Work

By GEORGE M. GILBERT

THE foreman looked at the casting on the floor in disgust. An error had been made in the pattern shop or the foundry, he did not care where, and there was four inches too much iron on the bottom of a huge cast-iron press frame. The casting was twelve feet high, almost four feet square on the bottom, and weighed about eight tons.

How he wished for an open-side planer! How he wished some one had been a little more careful! But wishes would not take iron off.

The machinist who had the job in hand ventured a suggestion.

"We might swing it in a lathe," he said, "but I don't believe we have one large enough."

"Our largest machine would not swing it, and anyway, it would take all the power in the shop just to keep the weight moving," the harassed foreman replied.

"Now, if we had a milling attachment that we could put on the rail of the planer, we might be able to put the casting on the table, and face it off that way," the machinist added.

THE foreman nodded assent, saying nothing. An idea was developing in his mind. If the milling attachment scheme were carried out, the work would be stationary and the tool would move. But why mill it when it would be done on a planer?

"How would it do," he said, "to put the casting on some blocking on the floor at the side of the planer, and mount a tool in some way so that it would be carried past the casting by the planer table?"

"We could certainly cut a groove in it that way," the machinist returned, "but how are you going to get the entire surface faced off?"

"The table moving back and forth will provide one motion, and we can arrange a slide of some kind to feed the tool up and down. In fact, I have the idea. We will take the cross rail off of the planer and mount it on a large angle plate, which we will bolt to the planer table. Then we will have something like a traveling head shaper that I once saw in a great engine works."

An ingenious set-up in a general jobbing shop for planing the base of a huge casting

The machinist looked at the work and then went off to the planer, which was 36 by 36 in. under the rail and had a 16-ft. table. It looked like a pretty big undertaking. He had fleeting visions of complicated set-ups, and trouble, but suddenly the idea clarified itself.

He set about to rig up the job as shown in the illustration. The casting was dragged over to the side of the planer and jacked up so that its center was about on a level with the table. He obtained the required blocking from the yard and fitted it in so that it was pretty solid. He made a couple of holes in the floor for bolts to hold the casting in place, for although it was very heavy, he knew that it might move under the strain.

From the tool room he brought a big angle plate that was usually used on radial drill work. It was about thirty inches on each face and had numerous holes for bolts. He bolted this to the platen of the planer and arranged stops to prevent it from moving, just as if he were going to plane it.

The entire cross rail of the planer was next taken off. This was bolted on the angle plate so that it hung over the side of the planer table as shown. It required quite a few bolts and a good many blocks and shims to get the rail fitted to the angle plate, for the back of the rail was not flat. However he finally had it fastened in place so that it would not move.

He had to make a special tool holder to hold the tool. It did not seem necessary to have a clapper box action, so the tool holder was merely a block.

WITH this done he lined up the casting with the travel of the table. The tool was fed into the cut by pushing it out of the holder the required amount. He put the planer table in motion, the dogs being set so that the tool just passed by the casting. For the down feed, he mounted the table, and rode with it, while he fed the tool by hand at the end of each stroke.

When the job was finally done, the machinist and his foreman shook their heads with a "never again" expression, but still they had a satisfying feeling of having triumphed over an unusually difficult problem.

Worn-Out Milling Cutter Used for Light Shaping

MUCH is said about the versatility of the lathe, but some of our other friends among the familiar machine tools possess much of that quality. How an ordinary hand miller can be employed for light shaping with the use of an old, worn-out, or damaged milling cutter is shown in the accompanying illustration.

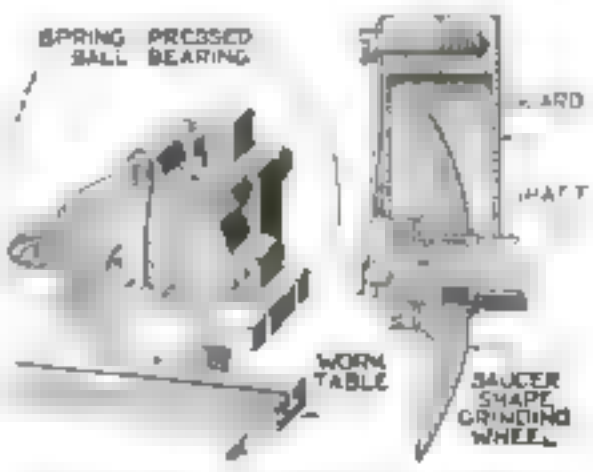
How an ordinary hand miller is used in shaping small work

A few teeth are ground out of the milling cutter ahead of the tooth that is to be used. The cutter is mounted on the spindle as usual, and the arbor support used to clamp the cutter against rotation. To do this, the center is removed from the support and replaced by a machine bolt fitting the center hole as nearly as possible, and the cutter clamped under the head of the bolt. In order to allow more surface for gripping, it is well to grind a shallow notch into the cutter near where the bolt head will come. The lever handle is used to move the milling machine table.

It will be seen that the particular piece shown in the illustration could not be completely milled even with an end mill. It is a shaping job. There are many such cases. In the small shop that does not boast of a shaper, or where the shaper is tied up on more important work, this simple expedient will often be found handy. It will be clear, of course, that even in a groove as shallow as that in the part shown, several light cuts must be taken to complete the job.—H. Simon.

Spring Improves Old Grinder

IN THE accompanying illustration is shown an easy and accurate way of grinding the side of a piece of work on a surface grinder without the chattering that often happens when a spindle is worn. An arm of 1/32-in. spring brass presses a ball bearing against the center of the spindle with sufficient force to take up the end play. This method has been used a number of times.—Joseph C Fisher.



A way to prevent chatter when grinding the side of a piece of work on a surface grinder

Rubber-Driven Toy Tugboat

By Dick Hixon

THIS realistic little tugboat is driven by the simplest of all power plants —a rubber band motor. It is, therefore, easy to build and inexpensive.

Clear white pine is the best material for the hull, although any other soft, close grained wood will do. Shape the hull as shown from a block 1¼ by 4 by 13 in. and hollow out the inside for buoyancy as in Fig. 2. Turn the hull upside down on a ¾ in. thick piece of wood and mark around it. Saw out the deck thus marked but keep ¼ in. within the outline everywhere except at the very stern, as shown in Fig. 3. Then, when the deck has been nailed in place, there will be a natural rabbet or recess into which the bulwarks can be fastened.

The forward ends of the bulwarks can be steamed or soaked in boiling water until the wood bends easily. Before fastening on the bulwarks, however, build up the bow and stern with blocks shaped as shown in Fig. 3. A piece of tin

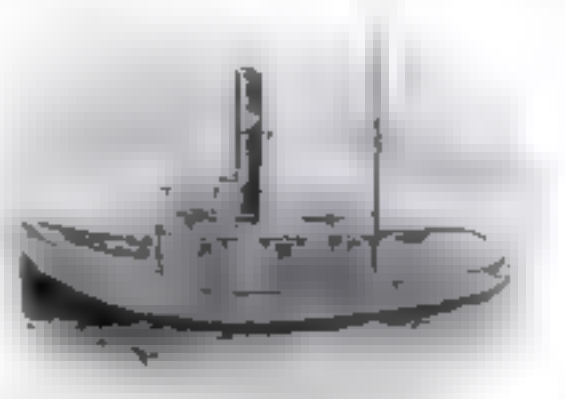


Fig. 1. Careful painting makes the little boat look more like a real model than a toy

Bore a hole at the stern at a slight angle as indicated to receive the ¼-in. dowel stick for the propeller support, which should be forced in tightly

Attach a keel made from a scrap of lead obtained at a plumber's shop. Have the keel too large to begin with and cut it down until the boat floats properly Make a wooden rudder and fasten it to the hull. Cut the propeller from tin, galvanized iron or sheet copper and solder it on a length of stiff brass wire. Bend one end into a crank for winding and the other into a hook to hold the rubber bands. A nut from a dry battery will serve as a washer. Strands of rubber such as are sold for airplane models are the best source of power, but heavy rubber bands bought at a stationery shop will serve the purpose.

The effectiveness of this toy depends largely upon the painting (Fig. 1). The hull may be black and green, black and vermilion, or all black; the cabin or pilot house, green or vermilion with white, black and gray trimmings; the funnel, black with a white star on each side and perhaps a red or green band with orange or gold stripes at the top. Give the entire boat a coat of spar varnish, and, if you can letter well, paint a name on the stern in bronze or orange.

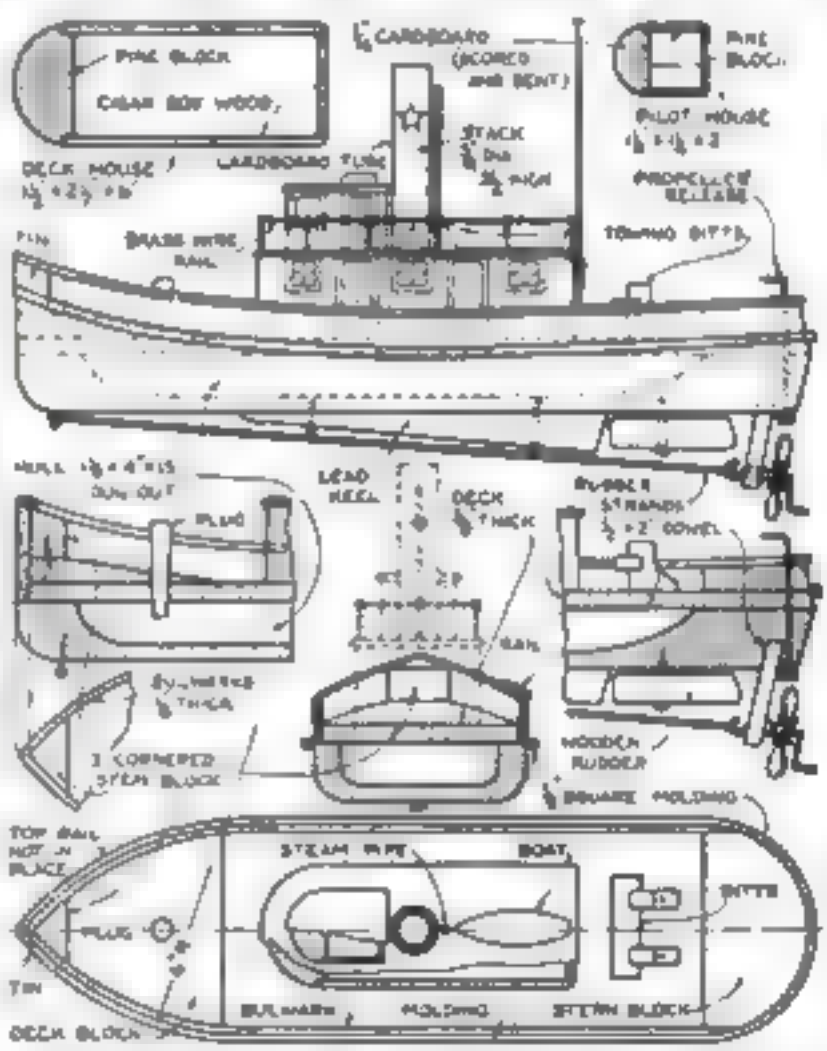


Fig. 2. Side view and deck plan of the tugboat and sectional views which show how the hull members are shaped and assembled

or sheet copper is fastened over the joint of the bulwarks at the bow and a ⅛ in. square molding of cardboard or wood is applied to cover the joint between the bulwarks and the hull.

A rail is made for the top of the bulwarks by sawing out one wishbone-shaped piece of heavy cardboard or thin wood and another semicircular piece for the bow and stern portions respectively; straight strips are used for the sections between. The superstructure and fittings are made as shown in the illustrations, which are very nearly self-explanatory.

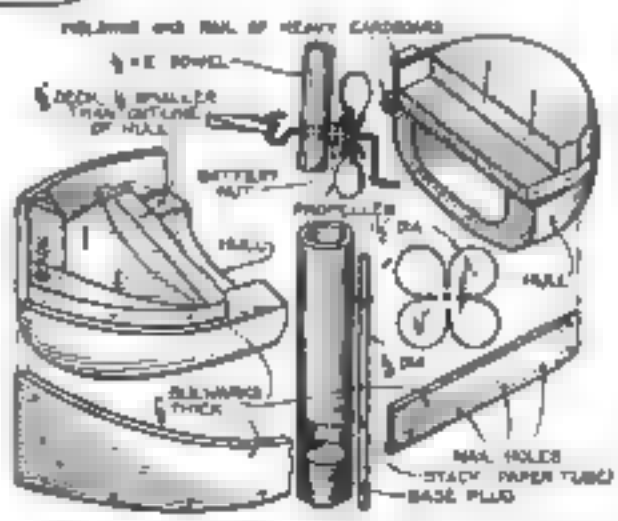


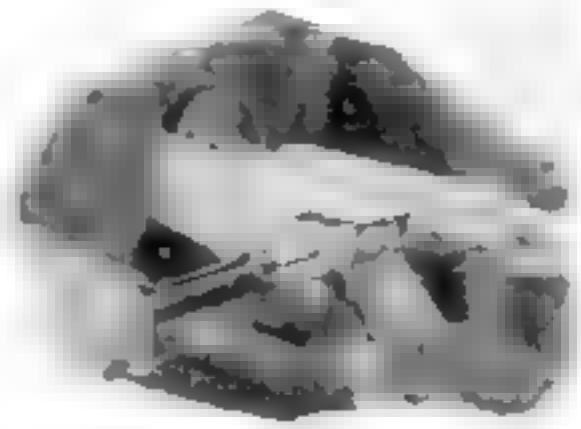
Fig. 3. Details showing method of assembling the hull, applying the thin bulwarks, and making the propeller and smokestack

Concave and Convex Turning

Hints for the Woodworker Who Has a Lathe—Beading—Chisel Handles and Mallets

By HERMAN HJORTH

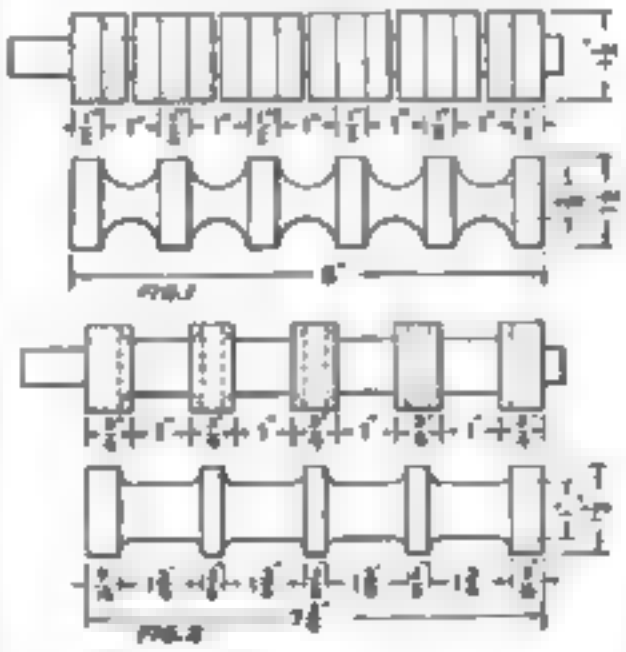
AS SOON as the amateur wood turner has learned how to turn a cylinder and make shoulder and taper cuts, he is ready to undertake work that requires concave and convex cuts.



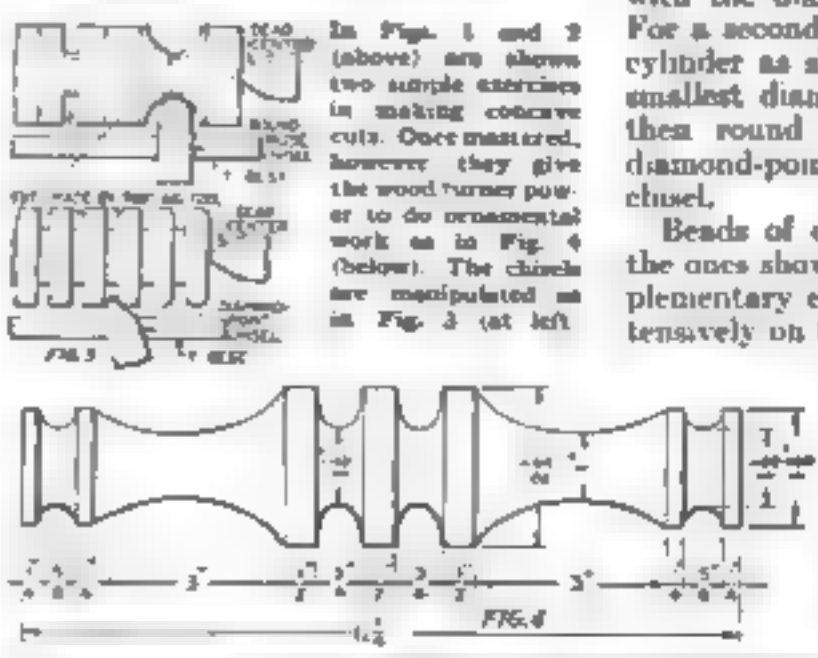
A round-nosed turning chisel held flat on the T-rest is used for shaping concave surfaces

To practice making concave cuts, first turn a cylinder 1½ in. in diameter and 8 in. long and lay it out as shown in Fig. 1. Set the calipers to ⅛ in. more than the smallest finished diameter and cut down with the parting tool at the center of the curves. Use the round-nose chisel for making the concave cuts, hold it perfectly flat on the T-rest (see Fig. 3). Begin the cuts a little inside the lines and gradually work down to the bottom of the cuts made with the parting tool.

Another exercise is shown in Fig. 2.



In Figs. 1 and 2 (above) are shown two simple exercises in making concave cuts. Once mastered, however, they give the wood turner power to do ornamental work as in Fig. 4 (below). The chisels are manipulated as in Fig. 3 (at left



Use a cylinder with shoulder cuts made as suggested in the second article of this series (May issue, page 94, Fig. D) and lay off the measurements indicated in Fig. 2. Make the concave cuts with the round-nose chisel. The supplementary exercise, Fig. 4, is designed to give practice on curves of longer and shorter sweep.

Convex cuts come next. Turn a cylinder 1½ in. in diameter and 8 in. long, lay out measurements according to Fig. 5,

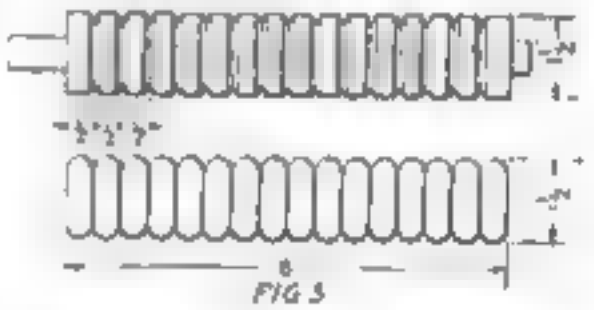


FIG 5

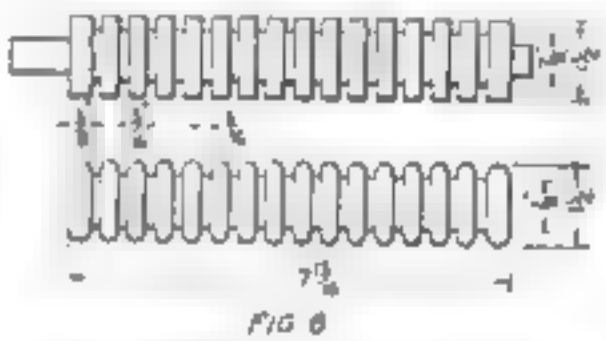


FIG 6

Useful exercises in making beads, which are frequently used in ornamental wood turning

and make small V-cuts with the diamond-point chisel. Round off the sharp corners with the diamond-point or skew chisel. For a second exercise (Fig. 6) lay out a cylinder as shown and cut down to the smallest diameter with the parting tool, then round off the corners with the diamond-point (see Fig. 3) or the skew chisel.

Beads of different diameters, such as the ones shown in Fig. 6 and on the supplementary exercise, Fig. 7, are used extensively on turned work. It is therefore important to be able to make smooth and well-rounded beads. Specially shaped turning chisels, called beading tools, from ⅛ to ½ in. in width, can also be obtained and used for this purpose.

(continued on page 94)

Concave and Convex Turning

(Continued from page 90)

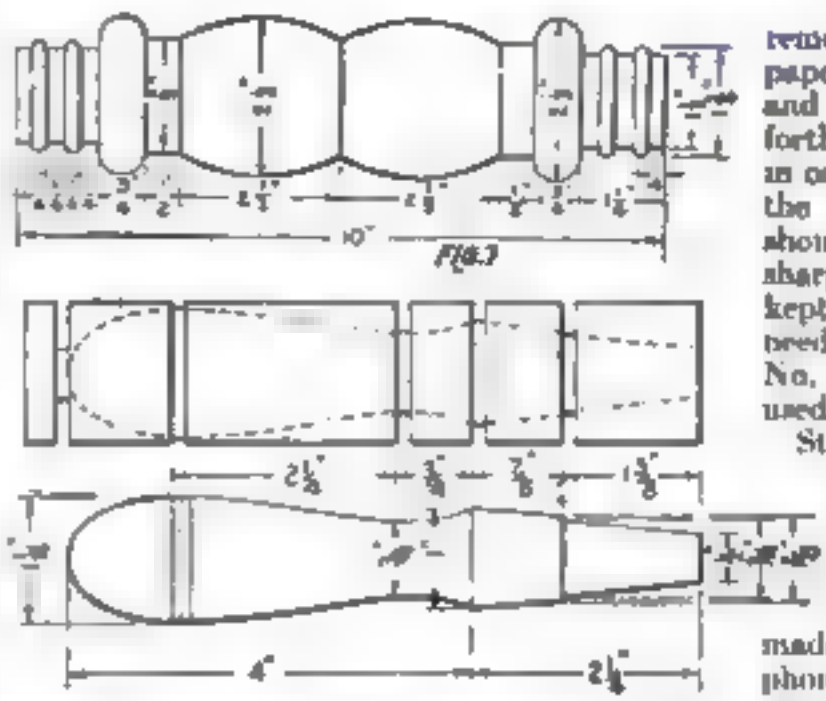


FIG. 8

In Fig. 7 is shown another exercise in turning to Fig. 8, a tapered handle for a socket chisel

For the purposes of illustration, each of the preceding exercises has been designed to deal with only one type of cut. In most turned work, however two or more of these cuts are combined, as in the simple projects illustrated in Figs. 8 to 11.

Chisel handles are of two kinds. One type, illustrated in Fig. 8, is tapered to fit into the socket of a chisel. As these tapers vary, it is necessary to verify or change the dimensions of the taper, as the case may be.

It should be remembered that the smaller end of all turned work should be run on the dead center, so that the end may be squared or rounded more easily and safely. In this case, therefore, the tapered end of the handle should run on the dead center. As the hole made by the dead center will not be objectionable in the finished product, it is better not to cut it away

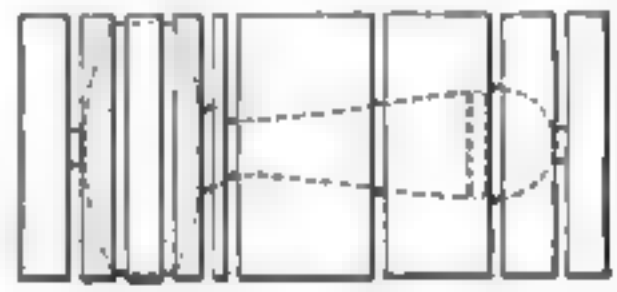
IT IS recommended to turn the taper first. The stock may be removed from the lathe and tried as often as necessary, until it fits the socket. The rest of the handle is then finished in the usual way, the concave part with the round-nose chisel and the convex part with the diamond-point or the skew chisel. The three lines on the handle near the end are cut for ornamentation. They are made with the point of the skew chisel.

The other kind of chisel handle is for the tang type of wood chisel. Each handle is fitted with a brass ring called a "ferrule," which prevents the wood from splitting when the tang of the chisel is driven into the handle. Ferrules can be bought in different diameters, according to the size of the chisel. They should fit so tightly on the chisel handle that they must be driven in place with a mallet. All handles should be sandpapered as smooth as possible.

When sanding in the lathe, it is best to remove the T-rest. The sandpaper is folded into narrow strips and moved rapidly back and forth over the work. If it is held in one place, rings will appear on the object being sanded. Care should be taken not to round sharp edges. When the tools are kept sharp very little sanding is needed. Ordinarily sandpaper No. ½ or 0 and No. 00 should be used.

Stocking darners are made in many different shapes. The one illustrated in Fig. 9 may be made in either one or two pieces. A clamp as shown in Fig. 10 may be made out of an old clock or phonograph spring and fitted around the head of the darner. This will hold the stocking tightly over the convex face during the darning process. If the ends of the spring are heated, they may be bent as shown. The edges should be smoothed with file and emery paper.

The mallet, Fig. 11, is a serviceable tool for any woodworker. It is made in



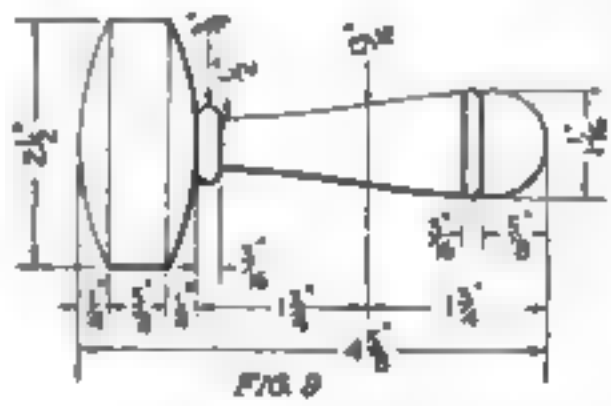


FIG. 9

A time-honored wood turning project—a stocking darner (Fig. 9) with a springy steel clamp for holding the stocking in place (Fig. 10)

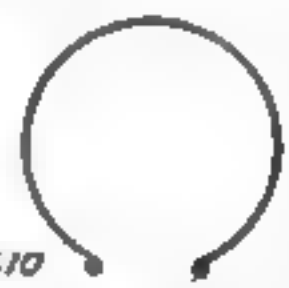


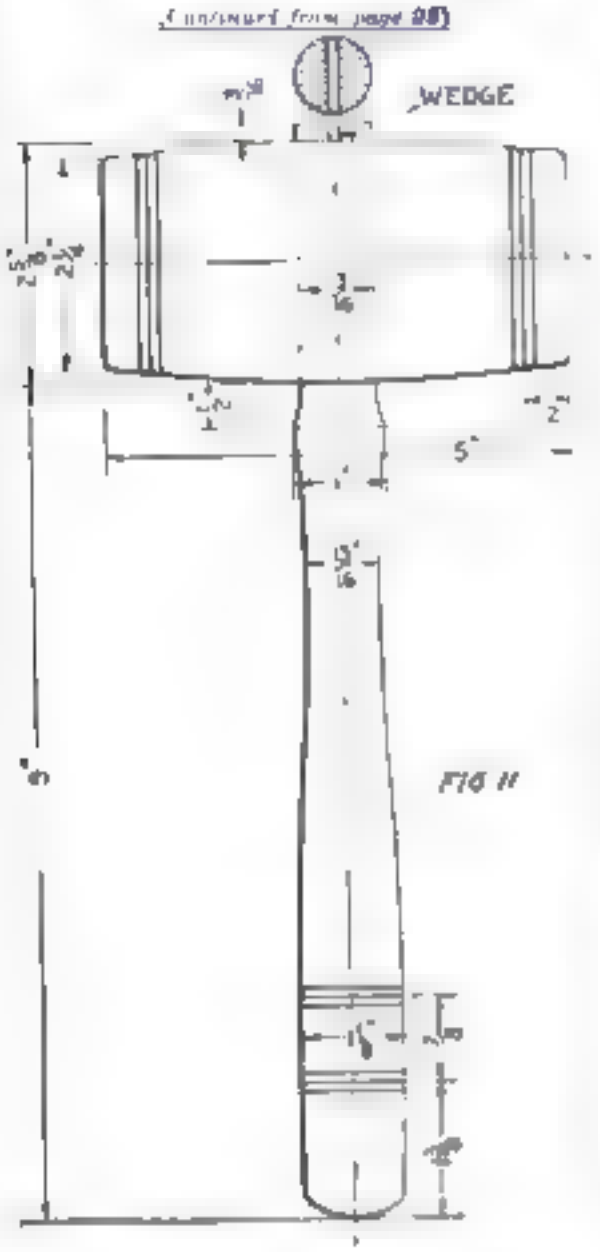
FIG. 10

two pieces. The end of the handle entering the mallet head should be turned very accurately to the diameter indicated. To do this, a gage is made by boring a ½-in. hole in a thin piece of wood. This gage may be hung on the dead center while the handle is being turned, so that it is not necessary to remove the stock when testing the accuracy of the diameter

When the head has been turned to size, the exact center between the ends is measured and a (Continued on page 93)

Concave and Convex Wood Turning

(Continued from page 92)



A design for a hickory mallet, which will give beginners good practice in accurate turning

line marked around the head at this point. Wrap a narrow strip of paper around the mallet head on this center line and cut it so that the two ends just meet. Remove the paper and fold it once. Wrap it around the mallet head again and mark a point on the center line at each extremity of the folded paper. These points, directly opposite each other, indicate the centers of the hole to be bored for the handle. The hole should be bored halfway from each side in order to get it true. If the halves should not meet exactly in the center, any unevenness may be removed with an inside-bevel gouge.

The mallet head may be held between the lathe centers or in a vise while the hole is being bored. In any case it is well to have someone "watch" the bit to see that it is held horizontally and parallel to the ends of the mallet head.

Before joining the pieces, the end of the handle should be split along the center with a hack saw. When the handle and head are ready to be glued together, a wedge is made and driven into this saw cut. The end of the handle may be allowed to project a little, or it may be cut off flush with the head. Hickory is the best of the commonly available woods for this project.

This is the third in a series of articles on wood turning. The fourth will appear in an early issue.

Wash bolted together back to back, channel iron sills from junked automobile frames make strong I-beams for use in house building. They will serve as a column, a beam, or a lintel over door or window openings in brick or tile buildings. W. W. S.

Rigging the *Mayflower*

(Continued from page 80)

The standing rigging. Note the evenness of the deadeyes. Each lower shroud passes up through the lubber's hole in the mast top, goes around the mast, and returns to the same side of the ship

slipping up (shown on Blueprint No. 84).

Fastened to the crosstrees at both fore and main there will be circular tops. The best material for the floor and rim of these is thin three-ply wood, but two thinner pieces of wood glued together with the grain crossing may be used; or celluloid or even stout cardboard will serve. Tilt your fret-saw table and cut the outer circle, then cut off a ⅛-in. rim. Cut the square lubber's hole out of the centerpiece and bore four holes in the middle of the rim, on each side, the forward ones being in line with the middle crosstree; three will be sufficient at the fore, if you prefer. Have the grain of the wood in line with the holes.

NOW cut a semicircular piece of thin cardboard with its lower edge serrated so that the serrations may be turned up and glued to the upper side of the top, to leave a bare ⅛-in. rim. Set the cardboard sloping out so that when the upper rim is set on, it will be about ⅛ in. higher than the floor. Glue the two ends of this together; then glue the turned-under points to the top. Press a bottle or other circular disk onto them until dry. Take the top and press the glued inner edge of the rim onto it, making sure that the two wooden parts are parallel and that the edge holes are in the right position with reference to the lubber's hole. Thin strips of wood may be glued on the outside to represent supporting timbers.

The completed top is firmly fixed to the crosstrees with the after edge of the lubber's hole against the mast.

The caps are next fitted; they are oblong pieces of wood made from two pieces of plywood glued together, or solid hardwood. The square holes fit the lowermast heads, and the round take the topmasts.

The mizzenmast is different. It has the masthead squared and has no cheeks, but instead a fore-and-aft hole through it for the halyard tie; the trestletrees are as before, but with two crosstrees. It is well to fit a cap to take the flagpole, although this may be lashed instead.

The position of the masts can be taken from the deck plan. The masts and bowsprit will, of course, be in line with the stem, but the mainmast will slope aft at an angle of one in thirty; the foremast will slope forward at the same angle and the mizzen aft at an angle of one in twenty. The bowsprit slopes up at an angle of thirty-two degrees.

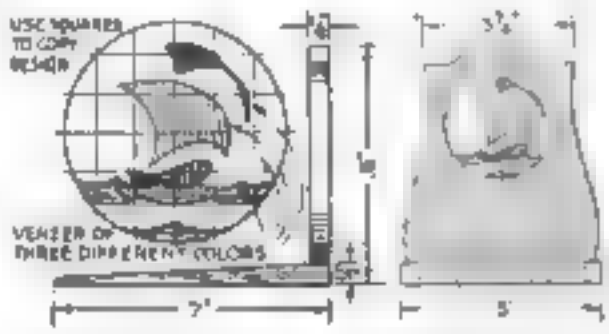
THE topmasts should have very small wedge cleats on either side to support the rigging and just below them a hole for the halyards, or, preferably, these masts may have the mastheads squared and small crosstrees fitted, as well as caps for the flagpoles. These do not show in the photographs, where the flagpoles are merely lashed on, but the model would be better for them. At about ⅛ in. from the heels bore athwart holes for the fids.

The bowsprit will require one or more wedge cleats to retain the gammoning, so that it will be (Continued on page 114)

Book Ends Embellished with Inlaid Designs

BOOK ends always make a welcome gift, especially if they are dovetailed, inlaid and finished with the best craftsmanship the home worker can apply. A design for book ends of this type is illustrated, but it can be modified in many ways by the maker, if he prefers to work out an original scheme.

The wood should be mahogany, black walnut, or dark, finely figured red gum.



How the book ends are made, a detail of the design on squares representing ¾ in. each

The inlay may be of any woods which give sufficient contrast of light and dark—holly, walnut, dark mahogany, satin wood, maple, or sycamore.

Make the inlay by placing pieces of the desired woods together, usually more than are required to allow for breakage and to give a choice of color. These should be of veneer thickness, considerably larger than needed, and all of the same size. Apply a light and narrow line of glue at the end of each surface but clear of the space from which the design is to be cut, and fasten together by pressure. Transfer the design to the top piece and cut carefully on the lines with a fine, sharp fret or coping saw.

Select and assemble the pieces face up on a piece of paper, and hold them in place with the smallest possible touch of glue. Glue a piece of thin paper completely over the face, later trim the outside edges to the desired circle. Remove the loose paper and glue from the back, sink the inlay in the face of the book end, and glue thoroughly. Clean off and finish with a sharp scraper.—C. A. K.

Simple Workbench Kinks

(Continued from page 76)

require. Clean up the edges with a file and, if you desire to give the hinge a hand-wrought appearance, hammer it with a ball-pein hammer, half on one side and half on the other, so that when it is bent as at *C* the hammering will show on both laps.

Do the bending over a small round steel rod in the vise as at *B*. Place a nail in the loop thus formed, drop both legs in the vise until only the nail is above the jaws, and squeeze them flat. Pull out the nail without removing the hinge from the vise, and with a hack saw cut two slots as at *D*. Remove the central portion between the cuts with a cold chisel as at *E*.

The other half of the hinge is made in the same general way, as shown at *F* and *G*. The parts are fitted together and the nail is driven through the loops, cut off and headed over. When the holes have been drilled, the hinge is complete, as at *H*. D. H.

Another Pipe Smoker Voices Tobacco Joy in Flowery Verse

His love of certain tobacco makes this New Jerseyite break into philosophic poetry

When a man writes poetry it's a sure sign he's in love with someone—or something. Some men are inspired by beautiful womanhood, some by a gorgeous sunset. Here's a man inspired by his favorite smoking tobacco

THE BLUE TIN CAN

I've tried the brands from every clime;
Choice mixtures with Perique;
But long—oh, long ago! I learned
The only brand to seek.

Each day our useless worries mount,
Our evenings to provoke;
But through the alchemy of fire
They vanish into smoke.

They vanish when our spirit bokls
No enmity toward man,
And smoke the sunshine bottled up
In Edgeworth's Blue Tin Can.

So smoke away! This loyal friend
Is void of bite or sting
For *He* is monarch of a world
Where Happiness is king.

Irving H. Walker,
Newark, N. J.
April 7, 1927

To those who have never tried Edgeworth, we make this offer

Let us send you free samples of Edgeworth so that you may put it to the pipe test. If you like the samples, you'll like Edgeworth wherever and whenever you buy it, for it never changes in quality

Write your name and address to Larus & Brother Company, 10 S. 21st Street, Richmond, Va.

Edgeworth is sold everywhere in various sizes to suit the needs and means of all purchasers. Both Edgeworth Plug Slice and Edgeworth Ready-Rubbed are packed in small, pocket-size packages, in handsome humidors holding a pound, and also in several handy in-between sizes.

On your radio—tune in on WRVA, Richmond, Va., the Edgeworth Station. Wave length 254.1 meters. Frequency 1180 kilocycles

Our Boy Rides the Air Mail

THE toy plane he uses cost less than four dollars to build—Is pedal driven and has wings and everything

By John P. Dunn

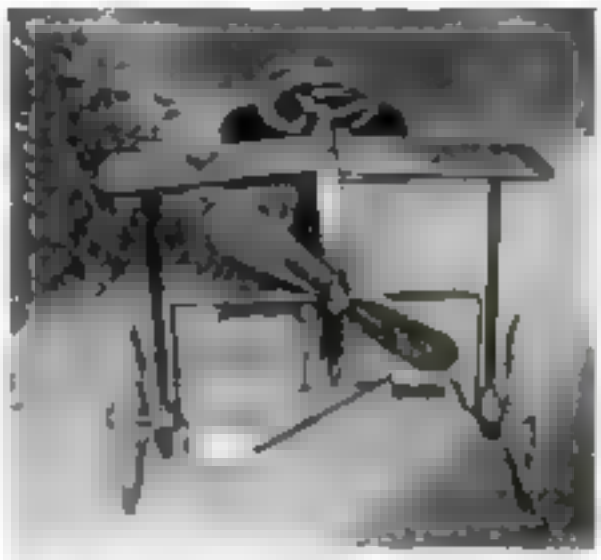


Fig. 1. Front view. The propeller blades are wedged into the hub with half-round sticks

COMPARED with the fun our boy has had with the auto-plane illustrated and the pleasure I had making it for him, the actual cost was very small—two dollars for wheels, sixty cents for iron, and not over one dollar for all other materials, including lumber, bolts, screws, and paint.

The body was made from a white pine board 1 by 12 in. by 3 ft. 6 in., cut as shown in Fig. 3. A ¾-in. hole for the steering rod was bored through at the angle indicated.

The two wings, seat and rudder were made from packing case lumber. The wings are ⅛ by 7 by 12 in., rounded on the outside edges. The seat is ⅛ by 7½ by 12 in., edged with a piece of galvanized tin 4 by 22½ in., which was beaded over wire and the corners rounded down to the front of the seat for neatness.

Fig. 2. Not only does the propeller turn, but the wings vibrate rapidly as the toy "flies"

Wire spoke wheels, two 12 in. in diameter and one 10 in., all with ¾-in. holes for the axles, were obtained. The driving axle was made from ⅜ in. round iron, formed cold in the bench vise. Threads were not run on any parts, but cotter pins and washers were used where necessary.

The two brackets that support the driving axle were made from ¾ by 1 in. strap iron, bent cold; each was drilled at one end to receive the ½-in. axle. The brackets were bolted to the body (see Figs. 1 and 3)

Each wing was attached with two small hinges so that it could be operated vertically by means of an eccentric attached to the axle by a set screw. The eccentrics (Fig. 4) were made from two 1 by 3 by 3 in. hardwood blocks turned on the shaft of a small motor. A ¾-in. recess was cut in the edge of each block, leaving a ½-in. collar on both sides. A connecting ring was bent from ⅛ by ¾ in. strap iron to fit in the recess of each eccentric. The strap iron was extended up to the wings and attached with a loose coupling. The mechanism depresses the wings about 3 in. with each revolution of the wheels (Fig. 2)

The foot pedals (Fig. 4) were made from two blocks 2 by 2 by 3 in., drilled ½ in. lengthwise and split. The halves were then screwed together over the axle.

The rear wheel bracket was made of ⅛ by 1 in. strap iron, drilled ⅜ in. at the lower end and ½ in. at the upper end. The bracket was attached to the body by two straps, bolted through (Fig. 3). Two screws were driven in lengthwise of the body to prevent

Continued on page 87

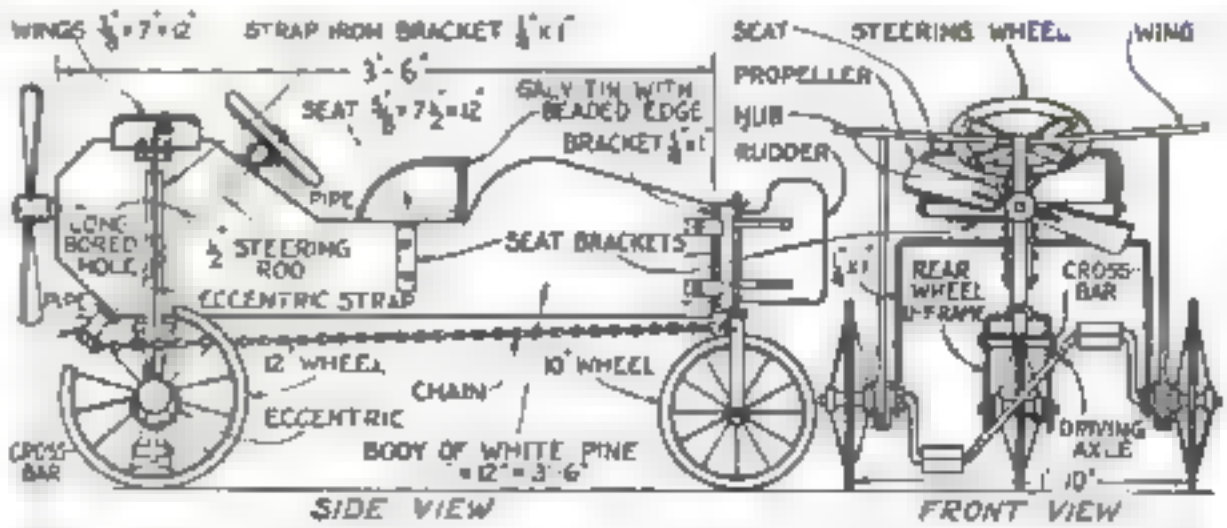


Fig. 3. Side and front views of the auto plane with the dimensions followed by Mr. Dunn. These could be changed, if necessary, to suit the size of the rider and the wings could be stationary

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

This solves the Graduation Gift problem

This day of a lifetime should be honored by a lifetime gift. And what sounder choice could you make than an Elgin watch! It has all the qualities you would have in that graduation presentation to your boy or girl . . . Modern beauty, newday style, unfailing accuracy and lifelong usefulness. These and other new models may be seen at your jeweler's . . . *Elgin prices range from $15 to $1,000; and each watch, at whatever price, carries the Elgin guarantee* . . . Elgin National Watch Company, Elgin, U. S. A.

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THE WATCHWORD
FOR EFFICIENCY AND
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All Prices slightly higher in Canada

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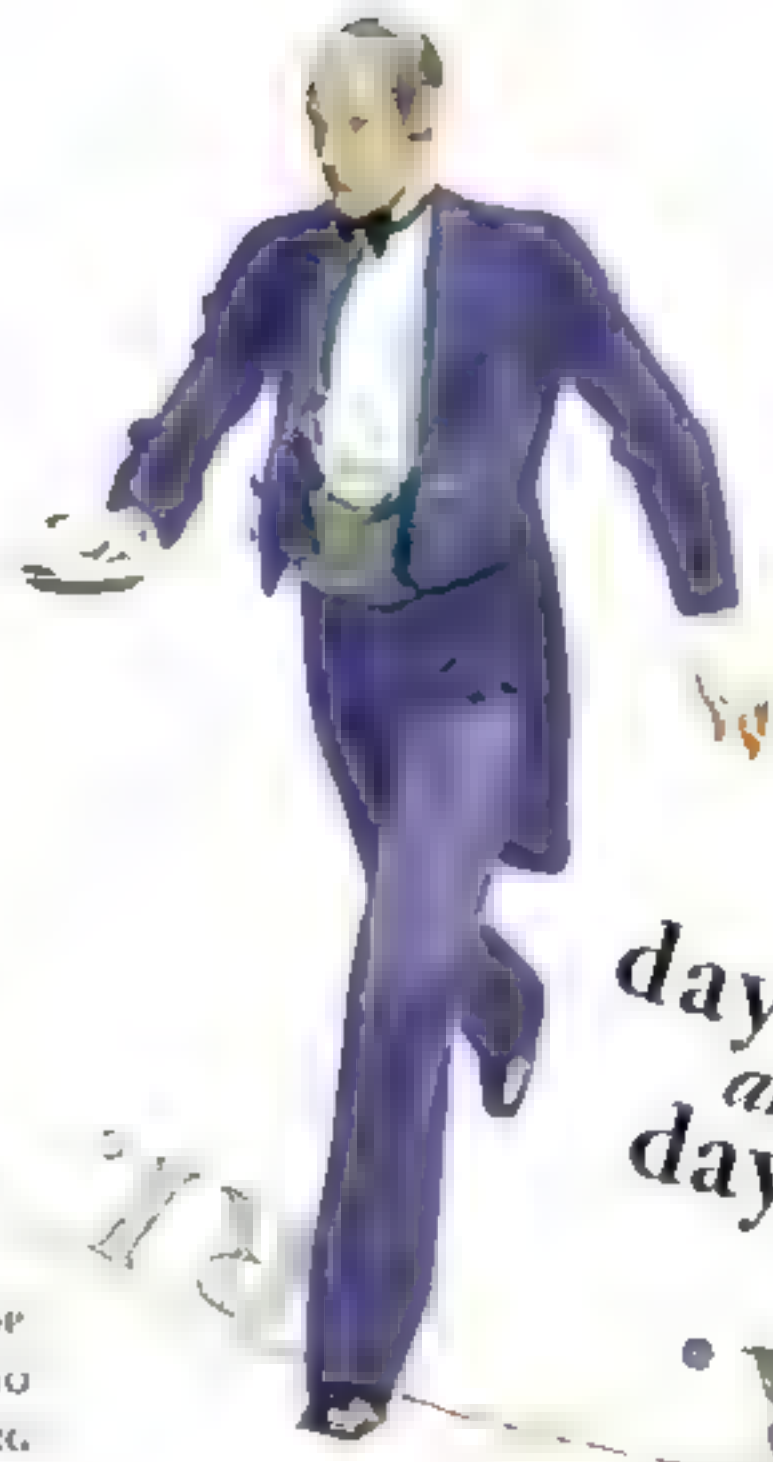


day in *and* day out!

TO A LOT OF SMOKERS STILL SHOPPING AROUND. HERE'S A FACT OF NO SMALL INTEREST. THE EVERLASTING DEMAND FOR A *REALLY* DIFFERENT ONE KEEPS FATIMA RIGHT UP AMONG THE BIG BRANDS, *IN SPITE* OF ITS HIGHER COST.

FATIMA

The Air Mail

(Continued from page 96)

the bracket from sliding up. A ¾-in. rod was run through the bracket to support the rear wheel. This rod was filed ⅜ in. round at the upper end and filed square at the lower end to fit the square hole in top of the inverted U-axle support. The rod was riveted solidly to the support.

The steering wheel (Fig. 4) was made from an 8-in. square of ⅜-in. birch. A ½-in. hole was drilled in the block, which was slipped over the shaft of a small motor and turned to 7½ in. diameter with a wood chisel, rasp, and sandpaper. The inner edge was turned with a ½-in. chisel part way, then the block was reversed on the motor shaft and cut until the ring slipped off.

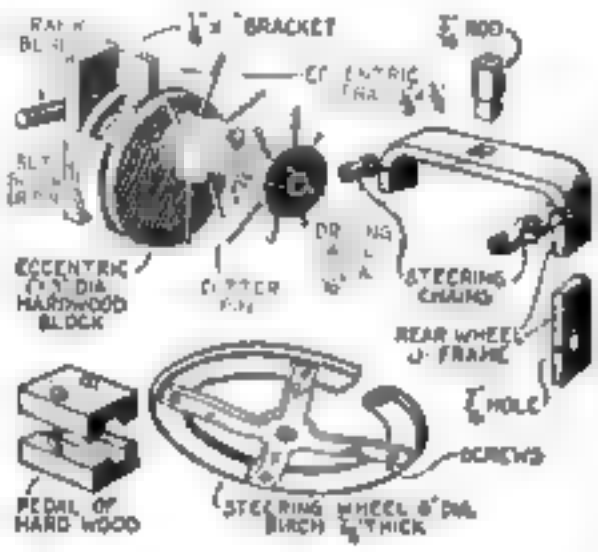


Fig. 4. How to make the wing eccentrics, pedals, steering wheel, and rear U-frame

The spider was cut from an old Ford steering wheel, obtained from a junk yard for ten cents. The ends of the spider arms were drilled and countersunk to fit the back of the wooden rim. A bushing 2½ in. long of gas pipe was forced through the hole in the steering wheel spider and attached to the steering rod with a stove bolt. Another piece of pipe was used on the lower end of the steering rod as a spacer to the strap iron crosspiece. The lower end of the rod was squared and riveted to the crosspiece. Two lengths of furnace chains were attached to the crosspiece, crossed under the body, and fastened to the rear wheel U-support by means of two key rings.

The propeller blades were made from two strips of white pine ⅞ by 3 by 8 in., with a ½-in. shank or tenon, which was inserted in the hub and wedged with two pieces of split dowel rod. The hub itself was turned from a 2½ by 2½ by 3 in. block of hardwood.

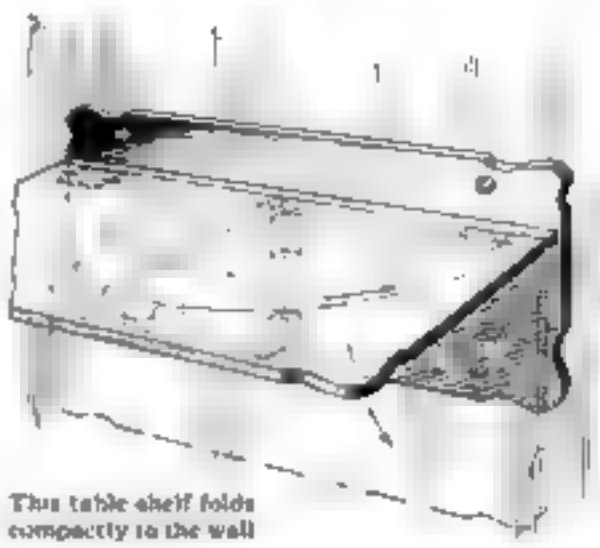
The body, wings and rudder were painted with dark red, and the ironwork and seat with black brushing lacquer. The top of the wings were decorated with a 5-in. black circle with a black star in the center.

One warning might be added: Fasten only one front wheel to the axle, or it will be impossible to turn in a small radius. Wheels may be purchased in pairs, one with a round and the other with a squared hole; otherwise a cotter pin or other means must be used to fasten one wheel to the axle.

"Tuckaway" Shelf Serves as Table

FOR a small house or apartment, this simple "tuckaway" shelf is an obviously convenient contrivance. It may be made any desired size and of any moderately hard wood, whitewood for example, to fit at the end of a passage or to be fastened to any wall where it will be of the most use. It may be used as an emergency table, a serving or sewing table, or a study table for a schoolboy.

When open, a surface of 15 by 24 in. is available, but when closed it projects less than 2½ in. from the wall. To make it of this size, get out the back ⅜ by 12 by 24 in., the shelf ⅝ by 14 by 23¾ in., the back strip ¾ by 1 by 23¾ in., and the arm ⅝ by 8 by 12 in.



This table shelf folds compactly to the wall

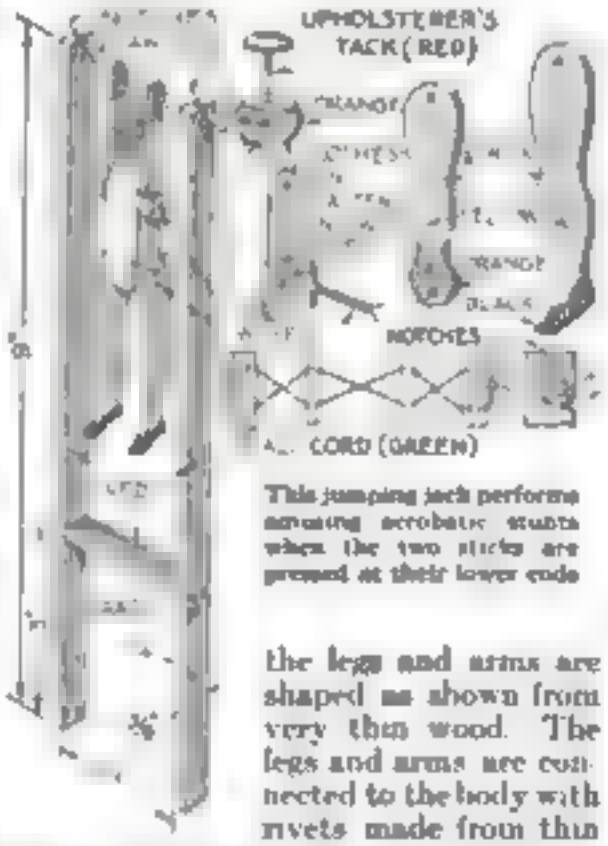
Saw the corner curves and the arm, and smooth and sandpaper the surfaces and edges. Assemble by driving 1½-in. No. 8 screws through the back into the ¾ by 1 in. strip, and attach two pairs of 6 by 8 in. stout brass butts (hinges), fastened securely with ¾-in. screws.

Finish by staining to suit and applying two or three coats of shellac. Rub with No. 4/0 sandpaper and polish with wax. Selected colors of lacquer may be used after the first coat of shellac if preferred.

Amusing Jumping Jack Has Clothespin for Body

ALL young children like to play with jumping jacks. The one illustrated is an old and familiar type of the toy and can be made easily.

A clothespin is used for the body, while the legs and arms are shaped as shown from very thin wood. The legs and arms are connected to the body with rivets made from thin wire as indicated in one of the details.

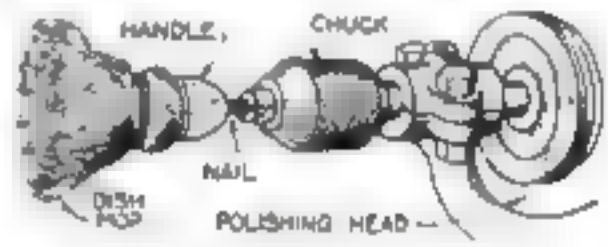


This jumping jack performs amusing acrobatic stunts when the two sticks are pressed at their lower ends

The sidepieces may be of varying thickness, but the sizes shown in the drawing will be found generally satisfactory. The man is suspended between the sidepieces with bright-colored twine. —F. Clarke Hughes.

Dish-Mop Buffing Wheel

A 5¢ dish-mop, commonly sold for five cents, has been found to make a good buffing wheel when fixed to a polishing head driven by a motor. The mop is cut off just back of the cotton strings and then bored to fit the spindle of the polishing head upon which it is to be screwed. Another way to mount it is to drive a nail into the head of the mop and grip the nail in the jaws of the chuck on the polishing head.—R. W.



One way to mount a five-cent dish-mop on a polishing head for use as a buffing wheel

Surf Sleds and Boards

(Continued from page 48)

ends should be rounded so that the galvanized sheet bottom can be carried up around them and fitted snugly at every point. Have the top and bottom galvanized sheets cut about ½ in. narrower than the width of the frame, so that there will be no possibility of their protruding and injuring the bather. Likewise, the corners of the sidepieces and handgrips must be rounded smoothly.

Before setting the sheet metal, paint the edges of the side boards with white lead and lay a strip of muslin or electrician's tape the entire length, taking care that there are no folds or wrinkles. Cover this with a coat of white lead. Then fasten the galvanized iron with nails about ¾ in. long, staggered about 1 in. apart. Drive them in well, then depress the edges of the metal into the wood (Fig. 3).

The cleats over the places where the galvanized sheets join each other should be drawn down tightly with screws, but first nail the ends of the sheets to the crosspieces to make the joints water-tight.

Follow your own taste in painting and trimming; green with orange striping is effective. In any case, be sure the first coat dries thoroughly before applying the second. Several coats of spar varnish will add to the life of the sled.

Blueprints for Your Home Workshop

ANY ONE of the blueprints listed below can be obtained for 25 cents The blueprints are complete in themselves, but if you wish the corresponding back issue of the magazine in which the project was described in detail, it can be had for 25 cents additional so long as copies are available.

Popular Science Monthly,
250 Fourth Avenue, New York

Send me the blueprint, or blueprints, I have underscored below, for which I enclose dollars cents

No.	Title	Described in Issues of		Price
1	Sewing Table	Feb.,	'22	25c
2.	Smoking Cabinet	*Mar.,	'22	25c
3.	End Table	*Apr.,	'22	25c
5.	Kitchen Cabinet	*May,	'22	25c
9.	Arbor, Gate and Seats	July	'22	25c
10.	Porch Swing	Aug.,	'22	25c
11	Bench and Tilt Table	Sept.,	'22	25c
13.	Tea Wagon	Nov.,	'22	25c
15.	Workshop Bench	Jan.,	'23	25c
17.	Cedar Chest	*Mar.,	'23	25c
18.	Phone Table and Stool	*Mar.,	'23	25c
19.	Grandfather's Clock	*Apr.,	'23	25c
20.	Flat Top Desk	*Apr.,	'23	25c
23	Colonial Desk	*Apr.,	'23	25c
23.	One Car Garage	*May,	'23	25c
24.	Gateleg Table	June,	'23	25c
26.	Canoe Sailing Outfit	July,	23	25c
27	Kitchen Cabinet Table	Oct.,	'23	25c
30.	Tool Cabinet, etc.	Jan.,	'24	25c
31	Sewing Cabinets	Feb.,	'24	25c
33.	Dining Alcove	Apr	'24	25c
34	Garden Trellises	May,	24	25c
37	Simplified Bookcase	Dec.,	24	25c
38.	Small Drop-Leaf Table	Jan.,	'25	25c
39.	Salem Chest of Drawers	Feb.,	'25	25c
41	One Tube Radio Set	May,	'25	25c
42.	Three Stage Amplifier	June,	'25	25c
43.	Four Tube Receiver	*July,	'25	25c
44.	Pirate Ship Model—Hull	*Feb.,	'26	25c
45.	Pirate Ship—Details	Mar.,	'26	25c
46.	Galleon Model—Hull	May,	'26	25c
47.	Galleon Model—Details	*June,	26	25c
48.	Sailing Yacht Model	*July,	'26	25c
49.	Broom Cabinet	Aug.,	'26	25c
50.	Airplane Model (Rise off-ground tractor 36 in.)	Sept.,	'26	25c
51.	Clipper Ship Model—Hull	*Oct.,	'26	25c
52	Clipper Model—Details	*Oct.,	'26	25c
53.	Clipper Mode—Rigging	Nov.,	'26	25c
54	Five Tube Radio Set	Oct.,	'26	25c
55.	Five Tube Set—Details	Oct.,	'26	25c
56.	Bird and Animal Toys	Dec.,	'26	25c
57.	*Constitution* Model—Hull	Jan.,	'27	25c
58.	*Constitution*—Rigging	Feb.,	27	25c
59.	*Constitution*—Rigging	Mar	'27	25c
60.	Welsh Dresser	Mar.,	'27	25c
61.	Viking Ship Model—Hull	Apr.,	'27	25c
62.	Viking Ship—Details	Apr.,	'27	25c
63	Toy Motor Boat—Hull	May,	'27	25c
64.	Toy Motor Boat—Details	May	'27	25c
65.	Six Simple Block Puzzles	June,	'27	25c
66.	Ship Model Weather Vane	Aug.,	'27	25c
67.	Toy Model of Lindbergh's New York to Paris Plane	Aug.,	'27	25c
68.	Magazine Rack Table and Book Trough Table	Sept.,	'27	25c
69.	Flying Model 3 ft. of Lindbergh's Monoplane	Oct.,	'27	25c
70.	Console Radio Cabinet	Nov.,	'27	25c
71	Console Cabinet—Details	Nov.,	'27	25c
72.	Doll's House	Dec.,	'27	25c
73	Doll's House Furniture	Dec.,	'27	25c
74.	*Santa Maria* Model—Hull	Dec.,	'27	25c
75.	*Santa Maria*—Rigging	Feb.,	'28	25c
76.	*Santa Maria*—Details	Jan.,	'28	25c
77.	Simple Pier Cabinet and Decorative Wall Shelves	Jan.,	'28	25c
78.	Simple Treasure Chests	Feb.,	'28	25c
79.	Electric Radio Set	Feb.,	'28	25c
80.	High Power Unit for Electric Radio Set	Mar.,	'28	25c
81.	Low Power Unit for Electric Radio Set	Apr.,	'28	25c
82	Simple Single-Stick Airplane Model 30-in.	Mar.,	'28	25c
83.	*Mayflower* Model—Hull	Apr.,	28	25c
84.	*Mayflower*—Details	Apr	28	25c
85.	*Mayflower*—Rigging	Apr.,	28	25c
86.	Racing Airplane Model 35 in. twin-pusher type)	May,	'28	25c
87	Seaplane Model 30 in.)	June,	'28	25c

*Out of print.

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This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

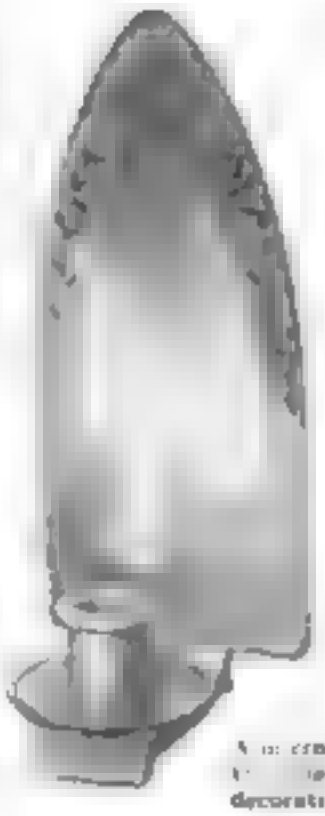
Colorful Craft-Work Novelties

How to Convert Scraps of Wood into Ornamental Desk Sets, Clock Cases and Candle Sconces

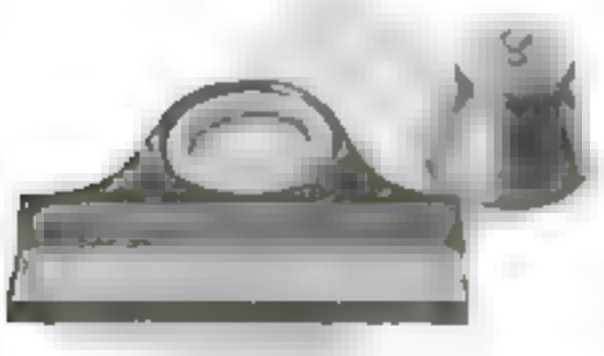
By Dick Hutchinson

THE popular brushing lacquer finishes have opened up a new field of craft work in wood. It is now easy to make colorful and beautiful novelties such as those illustrated. And it is not necessary to own a woodworking shop to turn out a few of these pieces. Many can be made with a few hand tools and, at most, a small lathe.

If you prefer to work in company with others, you may be able to do in your own locality what many others have done—enroll in an evening course in craft work in the manual training department of a near-by school. There you will find available all the machinery necessary to carry on the work. You will also have the advantage of excellent supervision and a splendid opportunity to develop projects like the ones to be described in the following outline.



A cut serves as the protector of this decorative sconce



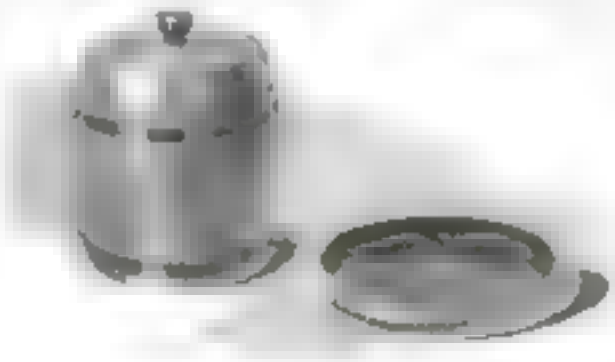
The pen tray has a circular recess for stamps, which is covered by the turned inkwell holder

Blotter Pad. Constructed of junk board, which may be procured at any wholesale paper house, 15 by 20 in. It is bound with ⅜-in. black gummed cloth tape, after which a sheet of nut-brown paper (catalog cover stock) 14½ by 19½ in. is glued evenly on each side, leaving a ⅜-in. margin. The corners are cut from ¼ in wood routed out on the back to receive the corners of the blotter and glued and nailed to the pad.

Pen Tray. Size 5 by 7 in. Cut out on band saw if possible. The groove for pens really should be cut on a "sticker," but can be cut with dado saws and finished by hand. Turn stamp box in lathe; it is 2 in. in diameter, ⅝ in. deep, and has a shoulder ¼ in deep and 2 ⅜ in in diameter to receive the inkwell.

Inkwell. Turned from a solid block, it is 2 ⅜ in. in diameter at the base, 1¾ in. at the top, and 1⅝ in. high. A recess is turned inside to receive a small round glass ink cup. The cap is turned from ⅞ in stock, a snug fit on the inkwell itself. A hole is drilled through the cap, and a turned handle glued on.

Calendar. Approximately 4¾ in wide and 3¼ in high, with an opening to accommodate a perpetual calendar, which may be obtained at a stationery store. The uprights should be glued and nailed to the base so as to tip back slightly, and either a metal or a wooden pocket should be fitted over the calendar opening to hold the calendar and keep it clean.



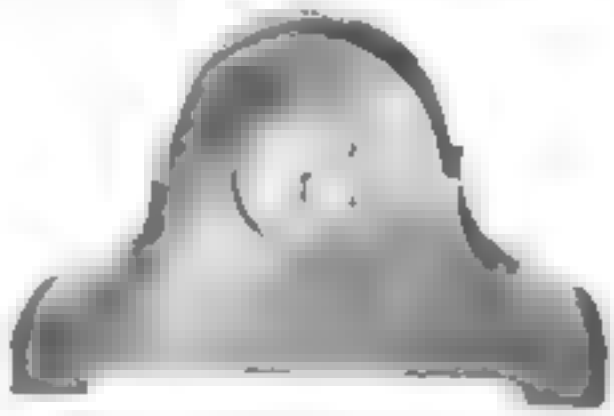
A barrel shaped container for cigarettes and an ash tray, brightly decorated with lacquer

Rocker Blotter. It is 2¾ in. wide and 5 in. long, rounded on the bottom. A slit is sawed into each end to receive the blotter. Drill a hole in the center of the top and glue in a turned handle.

Paper Knife. It may be made entirely of wood, or a hammered copper blade can be made and attached to a wooden handle with brass escutcheon pins, as in the case of the knife illustrated. The length is 7¾ in.

Candle Sconce. Length 10 in.; width 4½ in. at the base. The opening is cut out with a coping, fret or jig saw and the back is routed to receive the mirror. The arm may be straight or curved and about 8 in long. The saucer is 3 in. in diameter; it is glued and nailed to the arm. The candle cup is 1½ in. high with a slight flange at the top, and a ½-in. hole for the candle. The mirror is held with small brads, after which a piece of heavy paper is glued over the back of the plate.

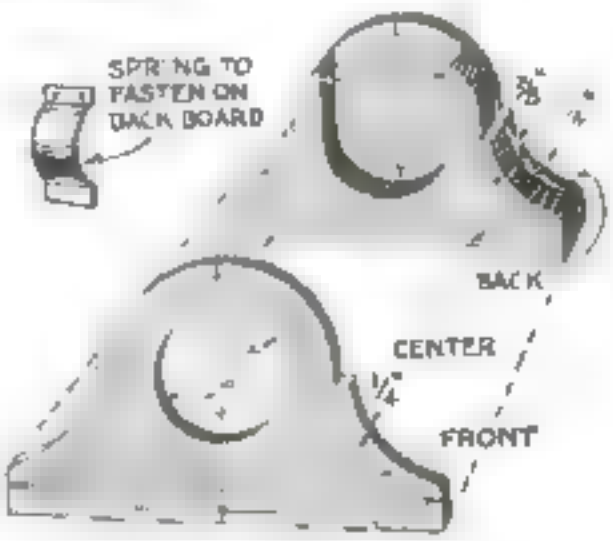
Desk Clock. Make a pattern from cardboard so that all pieces will be uniform. Lay out front and back on ¾-in. wood and the centerpiece on ¾-in. stock. Glue the back to the centerpiece and let stand until perfectly dry. Make a spring from thin sheet spring brass and fasten it in the center of the backboard with flathead screws. This is to hold a watch in place in the pocket, which should be lined with either leather or felt. Glue on the front, sandpaper well and finish with brushing lacquer.



Wooden case for holding a watch. It can be used either as a desk or a bedside clock

In decorating the finished pieces, a two-color scheme, that is, a plain body color with a harmonizing line, can be carried out, or a little floral design or a medallion may be applied with artists' oil paints, as in the case of the candle sconce illustrated.

The set consists of a desk pad, pen tray and inkwell, calendar case, blotter and letter knife



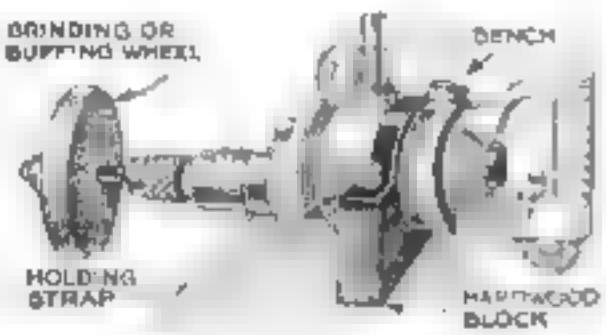
Three pieces of wood are sawed to shape and glued together to form the tiny case

Portable Tools

Continued from page 83

grinder in the shop and make a botch of it, so that the cutter bit on about six teeth when it started to cut? If the shop had one of these sturdy little portable grinders, the cutter could have been sharpened without removing it from the machine.

The method used for sharpening cutters is to bolt the grinder to the machine table, if it happens to be of the angle-plate type, or hold it in the vise, if it should be one of the tool-post type. The spindle then is freed from the power connection by the drive pin or back gears so



In an emergency a portable drill can be used for polishing or even light grinding

that it may be turned by hand. Set up a makeshift tooth rest for indexing the teeth. Bring the wheel into proper tooth contact by the horizontal and vertical adjustments while feeding the cut across the face by means of the longitudinal feed screw. The sides of the teeth may be ground by resetting the wheel and feeding it in or out with the in-and-out feed screw.

I have often watched a mechanic trying to put a finish on a hard piece of steel in a shaper or planer and have wondered why he had not tried grinding the finish with the tool-post grinder.

End mills, shell mills, slab mills, reamers, taps, and the like can be sharpened readily on the lathe with the aid of a portable grinder, often as well and almost as quickly as might be done with a special cutter grinder.

Many cylindrical grinding jobs also can be done on the lathe when the shop is not equipped with a regular grinding machine. This is an economical practice for the shop that has only an occasional job that must be ground, and it also saves the delay of sending the work out to another shop.

We might go on indefinitely discussing what can be done with the portable grinder, but it is not the ordinary jobs that require emphasizing. Look around the shop and see if there is not some "tough" job you can put them to work on. Too many of the little machines are tucked away in some dark corner of the tool crib and only see the light when Tom or Bill wants to grind a center. Get them out in the light and keep them oiled up and ready for business.

In the well-equipped machine shop we find portable drills, both electric and air driven; key cutters; filing, grinding and buffing machines; chisels, scrapers, and portable boring machines for boring engine cylinders (Continued on page 102)

A definite program for getting ahead financially will be found on page four of this issue.

Portable Tools

Continued from page 102

and similar work. In the larger plants are portable tools of the heavier variety, such as drilling, milling, and boring machines. The latter are found in shops that make a specialty of unusually large work. The job is set up on a planed cast-iron floor having T slots and bolt holes spaced as on machine bases and tables and serving the same purpose. Instead of moving the work about from one machine to another, the machines are taken to the work without disturbing its original setting until all boring, drilling, milling, and tapping have been completed.

IN THE manufacturing plants producing lighter work, portable tools such as power screw drivers, socket wrenches, grinders, drills, riveters, hammers, chisels, and calkers are great aids to production. In the railroad shops, cylinder boring and crank-pin turning machines save a great deal of time.

Tool- and die-makers are finding new uses for portable grinders and filing machines every day. Certainly in the automobile repair shops portable tools have come into their own. Cylinder boring and valve grinding, in particular, are done as a rule with the aid of electric drills. Simple and inexpensive attachments quickly convert a portable drill into a respectable drill press whenever needed.

Because the nature of their work often prohibits the use of stationary tools, repair machinists and millwrights probably find more constant use for the general utility tools than other mechanics. Even the carpenters have their power hand tools, including saws, drills, screw drivers, and lock and hinge mortising machines; and in the cabinet and furniture factories are to be found routing, shaping, sanding, and other special portable tools in large variety.

So valuable are these portable tools, not because of what they cost but what they do, that it is not pleasant to think of how often they are carelessly handled and abused. The result of misuse is that they are sometimes found out of order and fail to function at a critical moment, when things are rushing. They will stand a surprising amount of rough handling, but don't expect too much of them.

If an electric drill is only rated for a ¼-in. drill, don't try to use a ⅜- or ½-in. drill by turning down the shank. This is a practice that eventually ruins the tool. The motors are designed for a drill of a certain maximum size, and this rating should never be exceeded. If it is, the motor speed will be too fast and the power too low. And a burned armature is an expensive repair! Furthermore, the drill is out of commission until the repair is made.

If the motor fails to run, it may be only a minor trouble, such as a blown line fuse, a short circuit, broken connection, gummed commutator, or sticking or worn brushes. First, make certain that the trouble is not in the power line. Try a lamp in the socket, if you get light with the switch Continued on page 183

Portable Tools

(Continued from page 102)

on the trouble is inside of the motor.

Remove the brush end of the motor and examine the condition of the commutator, brushes, brush holders, and connections. If the brushes stick in the holder, that is one trouble, if they are worn down they need renewing. Worn-out brushes are also a cause of stalling or loss of power.

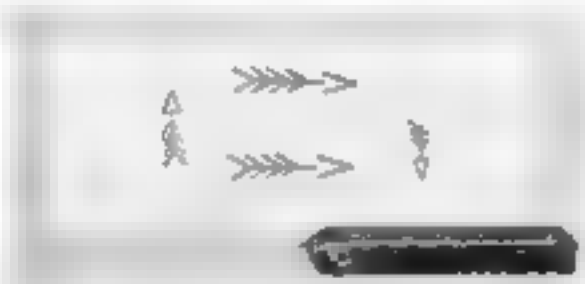
If the commutator is dirty or gummed up, it should be cleaned. Use a rag dipped in kerosene and then polish the commutator with fine sandpaper while the motor is running. Examine the connections for broken field wires; have any you find connected by an electrician, if you cannot do it yourself.

With a clean and polished commutator, brushes and holders in good condition, and no broken wires, the motor should run unless the armature has been burned. This is usually indicated by the appearance of rough black spots between the commutator bars. In this case the repairs should be made by an electrician.

Drill motors having a capacity of ½ in. and above are usually provided with a fuse. In case of trouble with the larger sizes, this fuse also should be examined.

Whether or not these hints have given you any new ideas on the use and care of portable tools, I hope that you will at least make a careful study of the labor-saving possibilities of all the portable tools that come your way. In that way you will be able constantly to discover new uses for them.

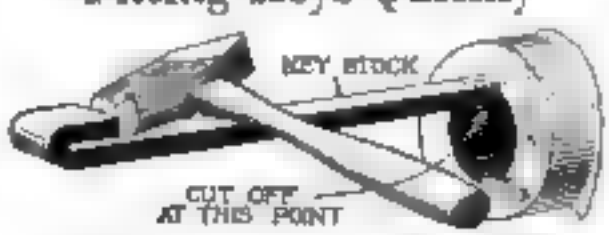
How to Stamp Index Arrows



Neat index arrows may be stamped quickly on steel by combining the letters Y, V and O

THE letters Y and V of any stencil set can be utilized to make neat and symmetrical arrow or index marks. The V, which makes the point or head, is followed by one or more impressions of the Y. Stamping an end of an O or the loop of a U in the V makes the head a bit more artistic.—F. W. B.

Fitting Keys Quickly



The key stock is bent over to form a head

THE fitting of keys in the hubs of pulleys and gears may be speeded up by using a piece of key stock about four times the length of the key with a hook bent at one end to provide means for tapping the key in and out. The extra stock is cut off and saved.—H. W.

Tools for Metal Working

The Outfit You Need for Hammering Copper and Brass and Making Jewelry and Models

By Edward Thatcher

MUCH decorative metal work—hammered copper and brass jewelry and models—can be made at the bench with the tools shown in the accompanying illustrations. Some of these you may already have, particularly if you do radio or model work.

While some of the special tools must be purchased at a jewelers' tool supply house, others may be obtained from any well-stocked hardware store or large mail-order firm. Get the best grade of tools you possibly can and you will be proud to own them.

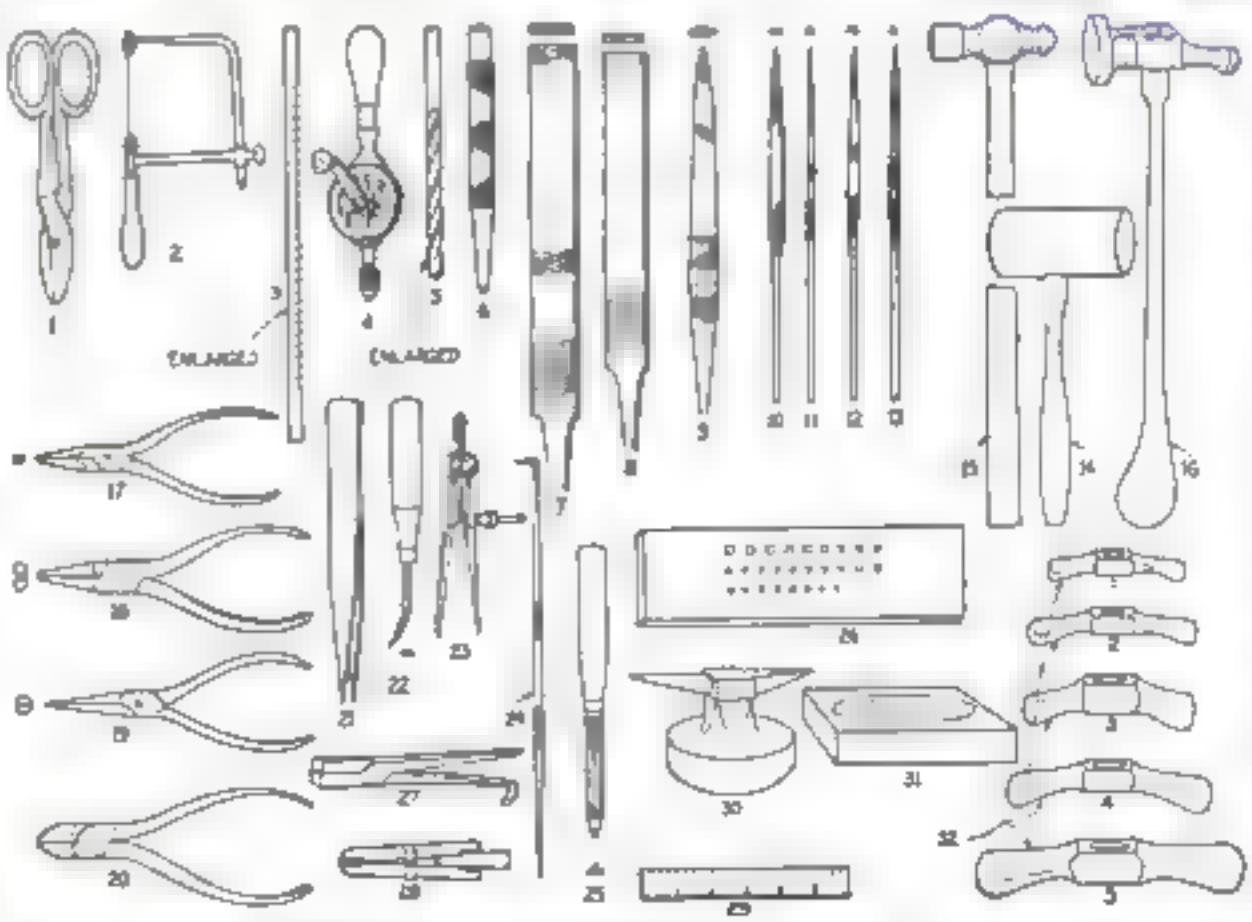
An excellent "raising" hammer made from a common brick hammer. Many hints on the choice of tools are contained in this article, the fourth in a series on decorative metal work by Mr. Thatcher, who taught the subject at Columbia University for fifteen years and is a skilled craftsman

The tools shown, which are the essential ones for bench use, are numbered to correspond with the following list:

No. 1. Snips or Shears. For very small work at the bench, light snips, 8 in. long over all, are best. If only one pair is purchased to start with, get a pair of 10-in. snips. The ideal equipment is one pair of 8-in. snips, one pair of 10- or 12-in., and one pair of heavy bench shears with a 6-in. cut and a length of perhaps 24 in.

No. 2. Jeweler's Saw Frame. For general bench work this should be about 5 or 6 in. deep from the saw blade to the back of the frame. Fitted with a suitable metal piercing or jeweler's saw blade this saw is used to cut out shapes from flat sheet metal. A large variety of work may be done with jeweler's saw blades held in a coping-saw frame of the better grade. The writer uses one about 8 in. deep for large work. For very small jewelry or similar work, a jeweler's light saw frame 4 in. or even 2 in. deep is useful. These frames may be obtained from 2 to 18 in. deep.

No. 3. Jeweler's Saw Blades. These are sold in bundles of one dozen or by the gross, which is the cheaper way to buy them. They should not be confused with coping or scroll saw blades for wood, they are very hard and made like tiny hack saws. There are eighteen sizes running from Nos. 8/0 to 12, the largest. No. 4 is a good size to begin with, and at least two or three dozen (Continued on page 106)



Some of the more essential tools: shears, jeweler's saw, drill, center punch, files, hammers, pliers, tweezers, burnisher, dividers, scriber, scraper, drawplate, ring clamp, anvil, borax slate, rule

Metal Working

(Continued from page 104)

should be purchased if you are far from a source of these supplies. Some of the finer ones may be purchased later on for very small work, Nos. 0 and 1 are much used.

No. 4. Hand Drill. This should have an accurate chuck for holding twist drills at least up to ¼ in. in diameter and it should be rather small and compact in design for bench work. As you will have much use for it, it should be a good one.

No. 5. Twist Drills. These are made for drilling holes in metal. The fluted drills usually furnished with hand drills are not hard enough for drilling metal. To start with, drills 1/16, 1/8, 3/16, and ¼ in. in diameter should be purchased and perhaps one or two larger ones, if your hand drill will take them. Several each of the smaller sizes should be obtained as they will break now and then. The 1/16-in. diameter size is much used to pierce metal when sawing inside work.

No. 6. Center Punch. The small cone-shaped point is used to make a slight depression in which the point of a drill is rested when starting to drill. The metal to be center punched is placed on a steel or iron anvil.

No. 7 Flat File. An 8- or 10-in. flat file about 1¼ in. wide, rough or bastard cut, is used for filing work roughly to shape before the smoother files are used.

No. 8. Flat File. An 8-in. flat file, about 1 in. wide, smooth milled cut, is used to smooth up all sorts of metal work and particularly to round or chamfer edges. The wooden handles for these files are sold separately and should be purchased for them.

No. 9. Crossing File. A 6-in. crossing file, cut No. 3-0 (fairly smooth) is useful for a variety of work such as smoothing up the inside of curves. Pointed half-round files are more common and are almost as good.

Nos. 10-13. Needle Files. These are used for finishing small work. At least four should be purchased, one knife shape, one round, one half-round or crossing (elliptical), and one three-square (triangular) in section. These files are very slender, from 4½ to 8 in. long, and each is provided with a smooth round shank and does not require a wooden handle. It is worth while to get a dozen assorted shapes. Smaller files much like these are called escapement files and are most useful for very small jewelry and model work.

No. 14. Wooden Mallet. Much used for flattening out and shaping sheet metal. A good thing to remember is "Do it with wood, on wood, when you can. The mallet may be purchased or made at home. It should be of beech or hard maple with a head about 2½ in. in diameter and 4 in. long, either square or round. Carpenter's mallets are rather clumsy for metal work. Sometimes hardware stores carry lighter ones, as the jewelers' supply houses always do.

No. 15. Machinist's Light Ball Peen Hammer. The head should weigh ½ lb. or slightly less. This tool should be of a very high grade.

No. 16. Chasing Hammer. This has a broad, flat face and an elongated ball peen, and is mounted on a peculiarly shaped handle, which is thin in the shank. The handles are scraped or filed down to the individual craftsman's liking. Hammers such as this are used for repoussé work or metal modeling. While not absolutely essential for some beginners' work, it is well worth purchasing. If you are to do any small work, particularly jewelry making, you are sure to need one. A chasing hammer with a 1-in. face is suitable for light work. Both the hammer and the handle must be purchased at a jeweler's or silversmith's supply house.

No. 17. Flat-nosed Pliers. This tool should be from 3½ to (Continued on page 107)

Keeping Your Home *Shipshape*

Closet Door Hooks and Shoe Rack

WHO has lived in an apartment house, a dormitory, a cottage, or in any close quarters and not longed for more hanging space for wearing apparel and a place where shoes and slippers might be placed off the floor and safely out of the way? Often a hook or two or a few nails are driven into the inside of a closet door, but the things hung thereon are always swinging between the edge of the door and the door jamb and are more or less of a nuisance.

The method of treating a closet door shown here is one solution of the problem. Four cleats, ⅝ by 3 in. and 2 in. less in length than the width of the door, are fastened to the inside of the door with screws. These cleats will carry as many as fourteen hooks, if necessary, for articles which do not need hangers.

It is obvious that the more hooks on the door, the more clothes there will be to swing between the door and the jamb. This is prevented by gluing a dowel in a hole in each end of all but the lower cleats. If more clothes are hung on the door than the dowels will control, tie a piece of tape to one dowel and fasten a stout rubber band to the other end of the tape so that it may be stretched over the clothes to reach the opposite dowel. If preferred, a piece of tape may be tied to each dowel, passed over the clothes and tied in the middle with a bowknot.

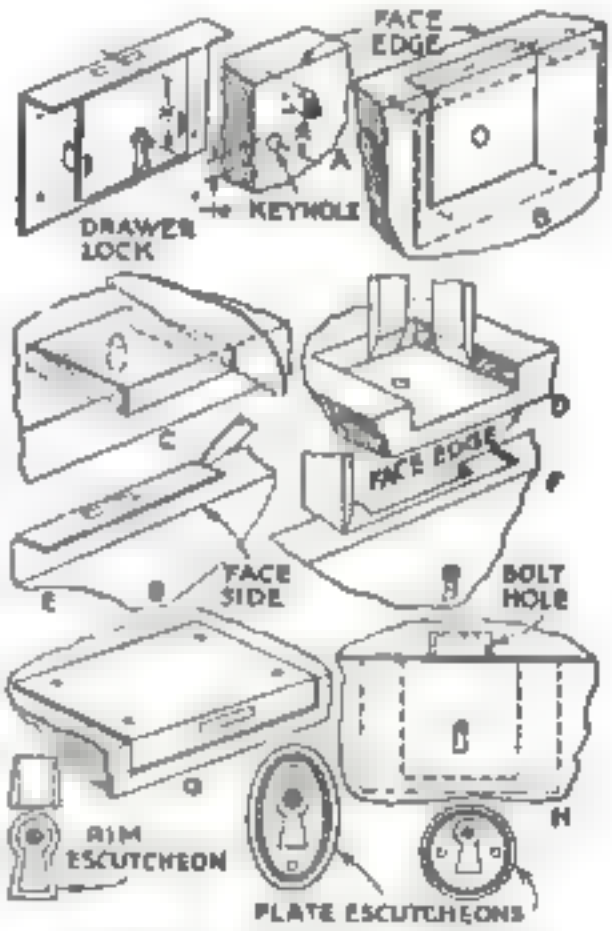
How to increase the capacity of a clothes closet with extra hooks and a shoe rack

Make the ends of the shoe rack ¾ by 4½ by 12 in. the two front rails ¾ by 2 in. and the same length as the cleats, and the back ¾ by 12 and 13½ in. less than the length of the front rails. Assemble with brads and fasten to the inside of the door with screws.

How to Fit Drawer Locks Expertly

THE first step in fitting an ordinary drawer lock of the type shown, regardless of the size, is to lay off distance Y of the lock from the top edge of the drawer front, adding a trifle, say ¼ in.—just enough so that the face of the lock will set below the edge of the drawer to allow planing if necessary. Mark this point with an awl, and through the front bore a hole as at *A*. This may be a ⅜-in. hole or smaller, depending upon the size of the lock. Push the projecting key pin of the lock into the hole from the back, center it, and pencil-mark around the front plate of the lock as at *B*. Lay the drawer front face down on the bench and with a fine saw make triangular cuts as at *C*.

Cut the wood out to receive the body of the lock as at *D*. Lay the lock in this space as at *E* and knife-mark around the faceplate. The back plate is seldom set flush with the inside of the drawer front, but this may be done, if desired.

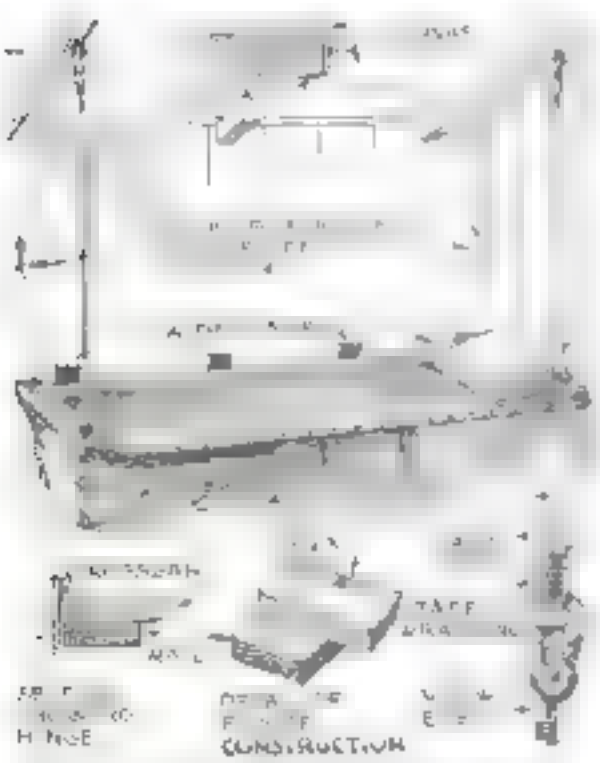


By following these steps, the amateur cabinetmaker can fit drawer locks easily

Cut out for the faceplate as at *F* and finish the keyhole with a pad saw or keyhole saw. If the work has been done accurately, the lock should appear about as at *G* when it is fastened in place.

Run the drawer partially in its case. With the key turn the bolt out and touch the face with black grease or paint. Close the drawer and turn the key until the bolt stops against the part that, as at *H*. This will leave a black mark on the wood. Remove the drawer and with a chisel a little wider than the thickness of the bolt, cut out the bolt hole.—C. A. K.

Simple Folding Cot for Emergencies



Even a back porch will provide extra sleeping quarters with this space-saving berth

WHEN visitors compel one to find extra sleeping quarters, a comfortable "Pullman berth" can be fitted up on the back porch, or even in a crowded laundry. The writer started making one at three in the afternoon and was sleeping on it at nine that evening.

The width of the cot is governed by any one of three items—the space available, the width of duck or canvas, or the size of the occupant. The framework consists of ¼ by 3 in. pieces screwed together and fastened to the wall with three hangers. In tacking on the fabric, lap over the edges as shown.—H. S.

Neat Trellis Supports Porch Flower Box

IN PLACING a porch flower box, it was found necessary to support the outer edge of the box. As simple props would have emphasized the height and bareness of the wall, a support was made in the form of a trellis, as illustrated. The uprights are 1 in. square; the cross members are ½ by 1 in. The idea presents opportunities for many variations in design.—A. E. Anderson.

A suggestion for supporting flower boxes

Metal Working

Continued from page 106

4 in. in length over all without side cutters or deep scoring on the jaws. It is better if the points of the jaws taper down to rather thin ends, to get into small places.

No. 18. Round-nosed Pliers. The jaws or nose are round in section and should taper down to rather fine points.

No. 19. Chain-nose Pliers. These have jaws which are half round or D-shape in section and taper to fine points. They should be 3 or 4 in. in length, and if the jaws are long and slender so much the better. For professional work these and the other types of pliers mentioned may be obtained with long noses, which are useful for many delicate operations, but they should not be purchased at first.

No. 20. Side Cutting Nippers. It is generally better to have a separate pair of side cutting nippers. The other types of pliers are so much used for forming metal shapes that cutters are apt to get in the way or mar the metal. The nippers illustrated are provided with jaws that cut right up to the ends, making it easy to reach in small places and snip off excess metal or wire.

No. 21. Tweezers. These are much used by the metal worker for picking up tiny bits of silver solder and small parts. They should be of spring steel 6 in. long and taper down to very fine points. They usually have to be purchased at a jeweler's supply house.

No. 22. Oval Steel Burnishers—Curved Blade. These burnishers, which are made with hard, polished steel blades, are used for smoothing the edges of bezels or bandlike forms which are used to set precious or semiprecious stones. They are necessary if you are to do any of this work. Burnishers are also used for smoothing or polishing certain portions of metal work. The blade should be 1 or 2 in. long. Many other types of burnishers are sold under the name of silversmith's burnishers.

No. 23. Spring Dividers. These form an important part of the metal worker's equipment for scribing circles in the metal and for accurately spacing division marks.

No. 24. Machinist or Engraver's Scribe or Marker. These tools are like a thick needle and some of the best ones have one end bent over at right angles to enable the user to reach difficult places. A common ice pick of the shorter variety makes an excellent scriber and a common steel knitting needle may be ground to a sharp point and used. Large steel sewing needles provided with a wooden handle made of a short length of dowel stick, are useful in laying out extremely small work.

No. 25. Hollow Scraper. The 2½ or 3 in. long blade is three sided or bayonet shaped, each side being hollowed out and each edge for the entire length of the blade being ground sharp. Scrapers are used to brighten up metal before soldering and for other purposes. Many mechanics make their own scrapers by grinding triangular files smooth and sharp. A knife blade makes a fairly good scraper, but it is handier to have a real one, if you do much work.

No. 26. Round-hole Drawplate. Drawplates are used in making wire and tubes. While copper, brass, silver, and gold wire may be purchased in practically any desired diameter, it is often necessary to draw down a wire to a smaller diameter, or to take a length of flat sheet metal and draw it out into smooth round wire. Then, too, if you have a drawplate you can make thin sheet metal into very accurate small tubes for hinge work and clasps. As a model maker I have found many uses for drawplates. It is not essential that a beginner own one, but most well equipped shops have one. The holes in drawplates are made in many shapes

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Metal Working

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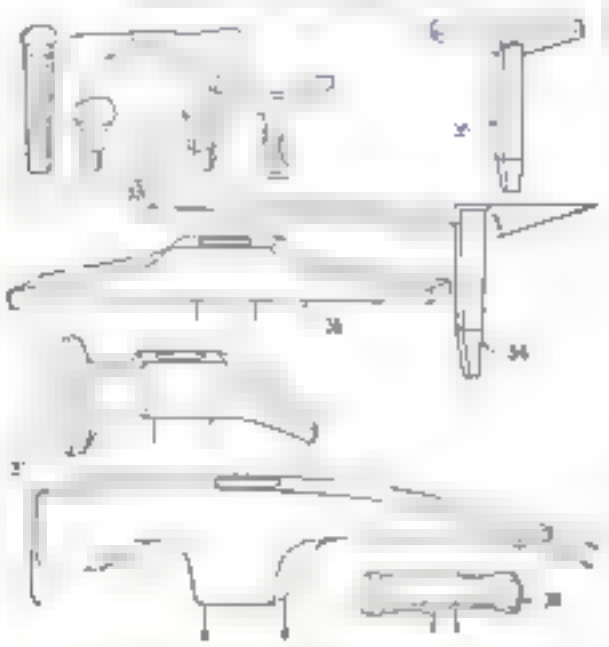

Set of stakes and raising and planishing hammers. A shoemaker's hammer will serve for planishing, and a brick hammer makes an excellent hammer for raising operations

—round, square, triangular, star shape and so on. For general use a drawplate having from twenty to forty holes, from ⅛ in. in diameter to a mere pinhole, are best.

No. 27. English Draw Tongs. These special tongs are used to grip the end of the wire as it is pulled through the drawplate. Common pliers are of no use, so if you get one or more drawplates you had better buy a pair of 8-in. draw tongs.

No. 28. Ring Clamp, Dutch End. This tool, which works much like a hand vise, is made of two hinged pieces of wood faced with leather jaws; one end is rounded over and the other is square across. A wooden wedge is pushed in one end to force the opposite jaws together. This tool is much used by craftsmen when making jewelry, particularly silver or gold rings.

No. 29. Steel Rule. A good 6-in. steel rule is splendid for laying out designs on metal, as it is more accurate than the cheaper wooden rules. For larger operations, a steel rule 12 in. in length is useful. Thin flexible corset steels, or pieces of clock spring, make excellent rulers for bending around cylindrical or curved work as a guide for scribing lines.

No. 30. Anvil with Base. This tiny bench anvil, about 3½ in. long, is much used by jewelers and craftsmen for light work. One horn is round and the other square in section. An old flatiron with the handle removed makes an excellent bench anvil for flat work. The heads of large round steel nails may be cut off and the nails gripped firmly in the vise so that the shanks can be used as anvils. Small round or square iron or steel bars or nails may be filed tapering at the ends to make anvils or mandrels.

No. 31. Borax Slate. A thick piece of slate about 3 in. square with a circular hollow ground in it is indispensable for hard or silver soldering. A little water is poured in the hollow and a lump of especially prepared borax is rubbed in it to make a creamy borax solution for use as a flux.

No. 32. Embossing Hammers. For raising and embossing the larger pieces of metal work such as bowls, trays and lanterns, specially shaped hammers and stakes or anvils are required. Embossing hammers are usually for inside work; that is, work placed over a hollow form or cushion and hammered to deepen it one way or another. The lightest one weighs about 3 oz. and the heaviest one 2½ lbs., they vary in length from 3 to 6 in. It is handy to have at least five of them, but if only one is to be purchased, it should weigh from ¼ to 1 lb. A good blacksmith can forge excellent hammers of this kind.

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Metal Working

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from mild or tool steel, provided a suitable model is furnished him. Sometimes a tack hammer with a long head can be used as a small embossing hammer for light work. The edges of the head must be well rounded over, or the head filed slightly dome shape and polished with emery cloth.

No. 33. Stakes and Anvils. This is a good set of stakes for a beginner. They are of malleable iron or cast steel and all the working surfaces are highly polished. The object of the strange shapes is to provide a number of curved or flat surfaces for supporting metal while it is being hammered with a raising hammer (quite different from an embossing hammer). The craftsman may find material at junk yards or about the scrap heaps of plumbing or machine shops that will serve as stakes.

No. 34. Tinner's Blow-horn Stake. The long horn or mandrel is about 18 in. in length and tapers to a fine point. The other end is half cone shape and comes in handy when making lantern tops. A blow-horn stake may be obtained from dealers in tinners' tools, any plumber can tell you where to get one.

No. 35. Tinner's Hatchet Stake. The craftsman will find this stake with its 10-in. blade a help when making sharp angles or bends in sheet metal, as when making lanterns. A length of hard maple board with a sharply beveled edge may be used for making angles in light sheet metal.

No. 36. Raising Hammer. Strictly speaking, "raising" means in metal craft work the placing of a disk of sheet metal over a stake and hammering around and around on it with a raising hammer. By this process the metal is raised up into bowl or other forms. This hammer is made of tool steel with the ends tempered for hard use. It is 6 in. long, 1 in. wide, ½ in. high or thick; one end is $\frac{5}{16}$ in. thick and the other end is about $\frac{7}{16}$ in. thick. The ends of these hammers are most carefully formed. First they are filed or ground off square across with the lower side of each end slanted in slightly toward the handle. Then all sharp edges and corners at each end are carefully rounded off, but the face itself remains quite flat. These may be forged by a good blacksmith or purchased of a dealer in metal craftsmen's tools.

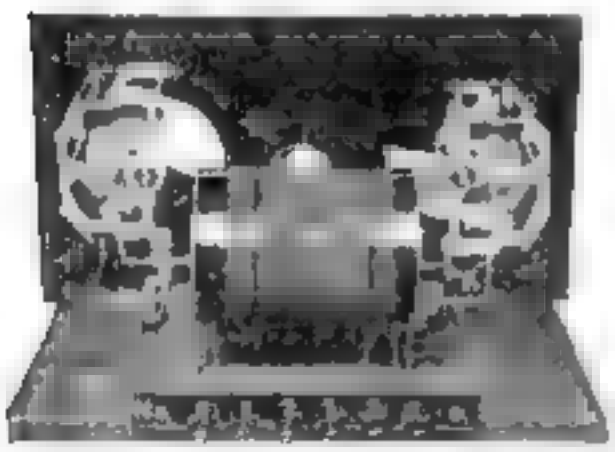
No. 37. Homemade Hammers. A common brick hammer, such as used by masons, makes an excellent raising hammer. Grind back the chisel-like end until this part of the hammer is about $\frac{1}{16}$ in. thick, then round off the edges and the corners. Grind the other hammer end square across and round over the edges and corners. Then you will have a fine planishing hammer, as well as a raising hammer. Brick hammers have a large eye in which the handle is firmly set—a decided advantage in a raising hammer. A good drop forged shoemaker's hammer serves well as a planishing hammer. After work has been shaped up with the raising hammer, planishing hammers are used to flatten the marks into the beautiful glittering facets seen in fine copper and silverware.

No. 38. Silversmith's Planishing Hammer. One end is flat and the other slightly rounded or dome shape. One weighing ½ or ¾ lb. is commonly used. A machinist's hammer with a smoothly polished face may well be used for planishing.

In the next installment of his series of articles on decorative metal working, Mr. Thatcher will give step-by-step instructions for making simple but effective candlesticks and trays. If you are interested in metal craftwork, which is constantly becoming more popular in both school and home shops, do not fail to preserve the entire series.

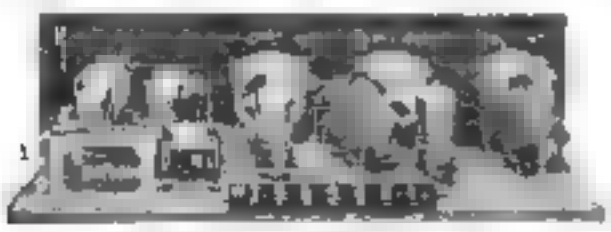
MAKE YOUR OWN RADIO SET

POPULAR SCIENCE MONTHLY publishes reliable blueprints of radio sets. These sets give excellent results and can be made by anyone who is handy with tools.



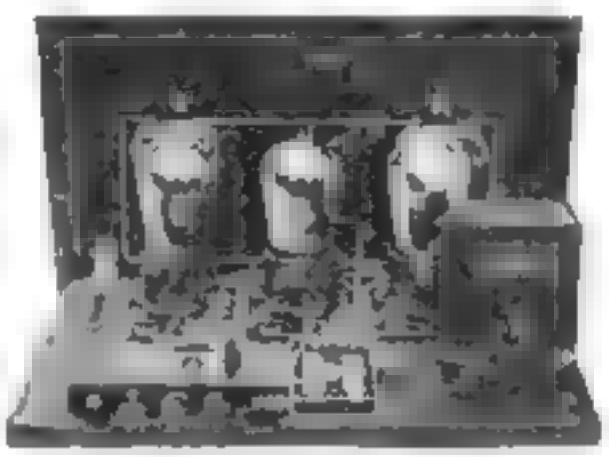
One-Tube Radio Set
Blueprint No. 41—Price, 25 cents

Describes a simple, one-tube regenerative receiver of the fixed coil type. The regeneration is controlled by a variable condenser and does not affect the wavelength adjustment. Quality of reproduction is excellent because no audio frequency current flows through the tickler coil. The coil is hand wound and the rest of the parts can be of any standard make.



Four-Tube Radio Receiver
Blueprint No. 43—Price, 25 cents

Describes a four-tube radio receiver consisting of one stage of radio frequency amplification, a regenerative detector, and two stages of transformer coupled audio amplification. It gives the greatest power for distance and volume that is obtainable from four tubes. Easy to build, uses any standard parts except the coils, which are simple to wind by hand. Two control tuning and regeneration does not affect wavelength adjustment.



Three-Stage Amplifier
Blueprint No. 42—Price, 25 cents

Describes a three-stage audio amplifier to be added to one-tube set of No. 41 to obtain loudspeaker results. Is equally useful with any other standard one-tube detector circuit. Consists of one stage of transformer coupling, followed by two stages of resistance coupling. Volume control is simple and does not affect quality of reproduction. This blueprint does not describe a radio receiver but is simply an audio amplifier to be used in connection with a one-tube radio receiver.

POPULAR SCIENCE MONTHLY, 250 Fourth Avenue New York City

Stepping the Mast of a Canoe

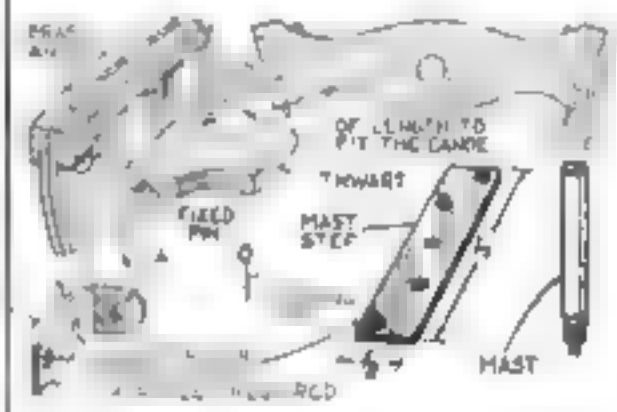
By J. V. Huzzard

FOR the canoeist who enjoys sailing, yet desires to keep his craft clear of entangling gear, the mast step presents a problem. The solution illustrated has several advantages. The crosspiece or thwart which supports the mast is easily made, solid in use, fair to look upon, and quickly removable.

Make a wrapping paper template for marking the wood, which may be almost any kind, not less than ½ in. thick. Bore the hole for the mast, and round and smooth the fore and-aft edges.

Obtain four brass angles, cut off all but ¼ in. of one side of each, round the corners, and drill a 3/16- or ¼-in. hole in each of the short ends. Drill and countersink two holes in the long ends.

Two of these angles are screwed under the inner wale just where the fore side of



The crosspiece that supports the mast can be removed simply by withdrawing four pins

the crosspiece is to come. The wood is held against them and marked so that short pieces of brass or bronze rod can be inserted as shown. The pins should project about ¾ in. Slip these through the holes in the two angles already in place and screw the other two angles to the wale so that they fit against the after edge of the thwart. Again the holes are marked, and the wood drilled so that removable pins may be thrust through the angles into the thwart to hold it firmly. Short chains or cords may be attached to the pins to prevent loss, and the holes wear better if bushed; certain types of paper fasteners will supply the bushings.

The foot of the mast is equipped with a long brass pin, which runs up inside several inches and projects ¾ in. this drops into a hole in a ⅛ by ⅝ by 3 in. brass plate which is screwed to the keel.

This method of stepping the mast proved so satisfactory that I later manufactured a thwart, fastened in the same manner, about 4 in. wide at its greatest dimension, flat on the underside, but rounded on top. Because of its width, it is much more comfortable to rest on than the regular thwart, and its position some 14 in. aft of the center permits the paddler to trim his canoe to a nicety.

Another feature of this thwart is that it can be bored in convenient places to carry blocks and cleats for halyard and sheet lines when sailing, both blocks and cleats being fitted with bolts and thumbscrews for the purpose.

A Seaplane Model

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oz. airplane dope or bamboo varnish, 4 oz. acetone, and 10 ft. 1/8 by 1/8 in. model airplane rubber. All these materials can be purchased from model airplane houses, and some of them you may be able to buy locally.

Before taking up the construction of the model, it might be well to point out that a great forward movement in seaplane development is now going on. At the time this is being written, Alan Cobham, the noted British airman, is making an extended trip in the gigantic *Rangoon*. The Royal Air Force has a flight of four great Supermarines under way. The Japanese Air Ministry is planning a trans-Pacific flight in four Dornier-Wal seaplanes. The outstanding speed records of the year were made in Italian Macchi and British Gloster and Supermarine racing seaplanes. Every battleship of the United States Navy is now being equipped with the new Vought Corsair seaplanes and Loening Amphibians. The Loening, too, is now being offered commercially. The new Fairchild monoplane, the new Fokker Universal, as well as the lighter commercial planes, such as the Eaglerock, Swallow, Travelair and Waco, are available as seaplanes through the use of Edo, Hamilton and Fairchild pontoons. Incidentally, to one accustomed only to land planes, it is a delight to fly in a seaplane.

FIRST construct the fuselage, or body which is a single stick of white pine 1/8 by 1/4 by 24 in., sanded smooth. Make a propeller hanger of piano wire. Bend a small loop just large enough for the propeller shaft to go through, then bend the ends together rearwards and downwards 1/4 in. and parallel to the fuselage 3/4 in. The propeller hanger is then bound to the fuselage with thread and also cemented. It should hold the shaft 1/8 in. above the fuselage. Make a rear rubber hook as shown and bind and cement in a hole 3/8 in. from the rear of the fuselage.

The cane or rubber guides are of piano wire. Make a ring 1/8 in. in diameter; bend the wires parallel 1/8 in. and then parallel to the fuselage 1/4 in. Bind and cement to the fuselage, one 6 1/2 in. and one 15 in. from the nose.

The undercarriage is made as shown of bamboo 1/8 in. in diameter, it should hold the top deck of the pontoons 5 in. below the fuselage.

The top ends of the struts are bent parallel to the fuselage 1/4 in. by heating them over a candle flame. They are bound in place with cement and thread—the front struts 2 1/4 in. from the nose, the rear struts 6 1/4 in. The lower ends of the struts on each side are bound together and cemented. The two vees should spread 4 1/4 in. apart at the bottom.

The L-shaped fittings which hold the pontoons are piano wire. Bend the wire in a tight loop 1/8 in. long. Next bend one end downward vertically 1/4 in.; this is later cemented to the side of the pontoon. Bend the other end outward horizontally 1 3/8 in.; this is later fastened to the top of the pontoon. The loop of the fitting should be bound to the undercarriage vees with thread and cement. Care should be exercised to align the fittings, as they govern the pontoon alignment.

THE tail plane is triangular; the rear side is bamboo 1/8 by 3/8 by 10 in. Bind and cement this spar in a notch on the undercarriage of the fuselage. Be sure the spar is horizontal before the cement sets. Make a knife slit 5 1/4 in. from the rear end of the fuselage on the under side. Into this slit fit and cement the thread that forms the other two sides of the tail. The two ends of the thread are then tied and cemented to the ends of the tail spar. The tail spar should be sprung slightly forward to keep the thread taut. Be sure the tail is symmetrical.

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A Seaplane Model

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The rudder is made of bamboo ⅛ by ⅛ in. The outline piece is 12⅝ in. long. Bend and cement ½ in. of the lower end to the underside of the fuselage, bend the other end around in a ring and cement it vertically to the rear end of the fuselage. It may be necessary to heat the outline over a candle to get the curve to work out properly. The rudder rib is bamboo ⅛ by ⅛ by 3⅝ in. It is forced into place and cemented. Let the cement set with the rudder slightly to the right. This will counteract the propeller torque, which turns the model to the left when in flight.

THE support for the tail pontoon is bamboo ⅛ in. in diameter and 1½ in. long. The top is sharpened to a wedge and cemented in a slit in the underside of the fuselage 1½ in. from the rear end. The strut should point at a slight angle to the rear for the sake of appearance.

To the lower end of this strut a fitting of piano wire to hold the rear pontoon is cemented. Make a small loop ⅛ in. long to run parallel to the strut, then bend the wire forward and upward ⅛ in., spread the forward ends ¼ in., and cement them astraddle the rear support. The rear pontoon should have about twice the angle to the horizontal that the front pontoons have. The rear pontoon, however, should not be attached to the fuselage until the tail wing is covered.

The main wing has two white pine spars a scant ⅛ by a scant ⅛ by 20 in. There are seven ribs, one located at the center line and the others spaced 4 in. apart progressively toward the tips, leaving a spar overhang of 1 in. to which the tip outlines are attached.

The ribs are bamboo a scant ⅛ in. square and 4½ in. long. They are curved over a candle flame. The highest part of the curve, which is ⅜ in. high, is located one third the rib length from the leading edge. The center rib should have a harder prompt like curve. The ribs should be bound to the spars with silk thread, four wraps each way. First put a drop of cement on each rib location. Bind the six outer ribs in place, then true up the wing and allow the cement to set.

SOAK the spars at the center line with water and bend the dihedral angle over a candle flame. The tips of the front spars should be 2¾ in. higher than the center and the tips of the rear spar should be 2⅜ in. higher than the center. Care must be exercised not to char the spars in the bending process. It might be well to practice a few bends on scrap before attempting to bend the spars themselves. After the dihedral has been made, bind the center rib into place.

The wing clips or supports are made of piano wire. Make two bends at the center of a piece of wire straight downward ⅜ in. apart, then, ⅛ in. down each end, make a bend upward so the wires will meet the spars ¼ in. on each side of the center line. Here at each end, the wire is bent parallel to the spar in a tight loop ⅛ in. long. These clips are shown clearly on Blueprint No. 87. Make two of the clips and fasten them to the spars with thread and cement. Align them carefully along the center line.

The tip outlines of the wings are bamboo ⅛ by ⅛ in. and extend 1⅜ in. beyond the spar ends. They are bound and cemented to the inner faces of the white pine spars. You can heat them over a candle and form them perfectly.

The propeller is made of soft white pine, ⅜ by 1¼ by 11½ in. Make a paper pattern of the blade outline and use it to draw the outline on the block. Cut around this outline to form the propeller blank. The hole for the propeller shaft should be drilled accurately in the center. Carve (Continued on page ...)

A Seaplane Model

(Continued from page 112)

the propeller with a sharp knife: make the rear side concave and the front side convex. The contour of the cross section of the blades should resemble a wing curve. The propeller should be cut rather thin and then carefully sanded smooth and balanced.

The pontoons have balsa wood sides 1/20 in thick. The front pontoons are of the step type, which is now common in seaplane and racing boat practice. They are 1 in. deep at the step, 1½ in. wide, and 6 in. long. The step, which allows the pontoons to skim the surface easily, is ⅝ in. high, and occurs 2¼ in. from the bow. Reproduce the shape carefully or follow the full size drawing on the blueprint so you will have a good streamline pontoon.

THE cross braces, which are bamboo ⅛ by ¼ in., are fitted into notches or recesses in the veneer sides and cemented into place. There is a brace at the bow and the stern. On the top deck there are three braces, one 1¼ in. from the bow, one 9 in. from the stern, and one vertically above the step. It is to the last that the undercarriage fittings are attached. On the bottom of the pontoon there is a brace at the upper and lower end of the step, one 1¼ in. from the bow and one 8¼ in. from the stern. When assembling the pontoons, be sure they are exactly true before allowing the cement to set.

The rear pontoon is a simple streamline type 1 in. deep at the greatest depth, 1½ in. wide, and 9½ in. long. The rear half of the bottom is slightly concave. There is a brace at the bow and the stern. On the top deck there are two braces, one 1¼ in. from the bow and one 1¼ in. from the bow; on the bottom, one brace 1¼ in. from the bow.

After the pontoon frames are assembled, give the entire frame of the airplane one coat of dope or bamboo varnish inside and out, pontoons, propeller and all.

The next step is the covering. Cover the top and bottom of the pontoons with Japanese tissue, sticking the paper in place with dope or bamboo varnish. Follow the contour of the surface carefully and get the steps covered neatly. You can allow a slight margin over the edges and, when the dope dries, trim it away with a razor blade. Give the finished pontoons three coats of dope or bamboo varnish.

THE rudder is covered on both sides with Japanese tissue. Cover the tail with tissue on the bottom side only, and cover the main wing on the top side. Stick the covering on with dope one section at a time. Be sure the covering is neat. After the dope dries, trim away the margins and give the rudder, tail, and main wing one coat of dope or bamboo varnish diluted with acetone—about 3 or 4 parts acetone to one part of dope.

To assemble the parts of the model, first mount the pontoons. These are fastened to the undercarriage fittings with cement. Glue carefully and block the model up so the pontoons will be in alignment after the cement sets. The front pontoons should be at a slight upward angle and the rear pontoon as mentioned before, should point upward at an angle about twice that of the front pair.

The propeller shaft is piano wire 1¾ in. long. Turn one end into a tight loop, pass it through the hole at the center of the propeller and sink the loop into the wood at the hub. Put a drop of cement over the end. Now turn the other end into a rubber hook as shown and put on a small washer. Make a piano wire "S" as shown for the rear of the rubber. Thread the propeller shaft through the propeller hanger or bearing and loop on four strands of ⅛ by ¾ in. model airplane rubber. Do not loop the rubber on tightly: it is better to have a little slack.

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A Seaplane Model

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The main wing clips straddle the fuselage and are held on by passing a rubber band over the wing and under the fuselage. The front spar will go about 8 in. from the front end of the fuselage.

To fly the model, set the wing so it will make a smooth, easy glide to the water. If it shoots up and stalls, slide the wing a little to the rear. If it glides too steeply, slide the wing forward. It is best to fly the model down wind. You may hand-launch the model and let it alight in the water or you may wind it up fully, about 325 turns, and it will take-off exactly as a large plane. This model, if properly made, will fly 1,000 ft. You can start it from calm ponds or streams or any calm water. It will not be damaged in landing in grass or on sand.

A FEW final hints might be added. Let the universal type of cement or glue set well before disturbing or jarring it. If you do not obtain Blueprint No. 37, you will find it best to make a paper pattern of the outline of the pontoon sides and the propeller blank outline. The pontoons and frame are, of course, waterproof, but the wing tail and rudder are not fully waterproof. They will stand wetting, but do not unnecessarily drench them. The complete model should weigh about 1½ oz.

The *Mayflower*

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vertical or sloping slightly forward of the hole in the stem. Abaft this, on the starboard (right) side, there is a cleat for the halyards.

To fix the lowermasts in position there will be needed 10 deadeyes with chain plates (wires, and the same number without. These should be heart-shaped, but circular ones may be used. They should be ½ in. long and have grooves around them and three holes large enough to take the thinnest cord, which will be referred to later. Boxwood, holly, and gum are the best woods for the deadeyes and blocks.

There are several ways of making the chain plates which hold them down. One is with No. 22 brass wire sprung round them, this is a neat method if well done, but the easiest way is to use No. 22 copper wire, twisting it under the deadeye and making a twisted eye in the lower end to take an escutcheon pin nailed into the hull. The correct chain plate would be a half-round band around the deadeye with eyes below to take a bolt to fasten it to a flat bar bolted to the hull. Be careful that the deadeyes sit close on the channels and that the lower eyes are nailed in a true line with the sheer. The uppermost deadeyes should be somewhat smaller.

For the rigging at least three thicknesses of cord are needed. Linen fishline is undoubtedly the most suitable kind. The thickest, for shrouds and the like, should be 18 thread; the medium, 9 thread; some 6 thread is also desirable; and the thin should be about as course as buttonhole thread. The best is a Jacquard #0 6, but this can be obtained only in large quantities or from firms which specialize in ship model supplies. A sewing thread might be found at a bookbinder's. White sewing thread will do but it is not so good. All of the heavy and some of the medium thickness should be stained a very dark brown, the remainder should be a light tan color—white or jet black does not look well on a model of this type. We shall call these cords A, B, C, and D, the thinnest.

The bowsprit having been glued in its hole, pass the gammoning, which is a heavy lashing to hold it down to the beakhead. This must be very tight, so it is a good plan to hang a heavy weight near the end of the bowsprit with another on the poop to

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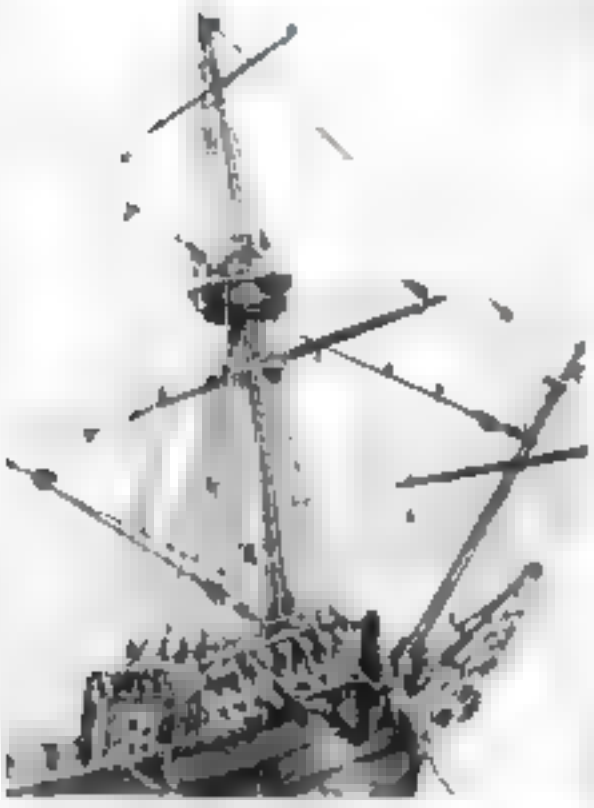
The *Mayflower*

(Continued from page 114)



Rigging of foremast and bowsprit showing fore, fore-top mast, main and main top mast stays

counterbalance it. The gammoning starts with an eye or hitch around the bowsprit against the cleat, goes through the slit from port to starboard, and so on round and round for from seven to ten turns. Note that the turns start from aft on the bowsprit and forward in the slit, thus crossing themselves every turn. Finish off by taking a turn round each half and then several turns round the whole

For the lower rigging (shrouds) at the main, pass a piece of A cord on the starboard side, up through the lubber's hole, around the mast, and down again. With fine sewing cotton, seine bind) a deadeye in one end. Put a knot in the end of a length of D cord, pass it through a lower hole of the upper deadeye—the one opposite the left eye, looking from the inside out—through the corresponding eye in the lower deadeye, and so on, draw this down until the deadeyes are about three times their length apart and let the end hang with a spring clothespin or similar clamp for a weight Seize a deadeye in the other end of the shroud to lie at the same height when the shroud is tight and snug to the mast, pass the lanyard and draw both down tight and even, and with cotton seine the two parts together close up under the top.

REPEAT this on the port side; then do the next pair to starboard, and continue until all are on with the mast standing central but drawn just a shade too far aft, so that it can be brought back later with the stays.

The fore and mizzen shrouds go on in the same way, except that as there is an uneven number the first ones go up one side and down the other

The stays come next. The fore and main should be of three parts of A cord laid together by twisting each part and letting the whole twist itself into a tiny rope. The mizzen should be two cords similarly laid up. Their upper ends go up between the crosstrees, around abaft the mast, and down. They are spliced or seized to their standing parts.

For the mizzen stay a deadeye is seized into a long strap (loop) round the mainmast, a deadeye is seized into the stay, and the two are drawn together with a lanyard. The mainstay comes down similarly to a very long strap which goes through the hole in the stem and passes on both sides of the foremast, with a deadeye seized in.

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The *Mayflower*

(Continued from page 1.3)

abaft. The forestay has its lower deadeye strapped to the bowsprit, 2¼ in. from the end.

The sheer poles are stiff wires lying along the upper edges of the deadeyes and are seized to the shrouds outside; they prevent the deadeyes from twisting. The ratlines (steps) may be of No. 24 black sewing cotton. They are clove-hitched to each shroud and must be tight across but not so much so as to draw the shrouds out of line. The easiest method of putting on the ratlines is to use a bent needle and start at the left. They come to within about 1 in. of the top where a wooden batten is seized to the shrouds inside. This futtock stave should be put in position after the sheer pole and should stretch the shrouds slightly apart. When hitching on the ratlines, leave the ends long. Brush glue or shellac into the end hitches and cut off the ends close when dry.

For the topmast rigging, twist smaller deadeyes into wires, pass them through the holes in the edges of the tops, and make eyes in the lower ends to seize to the futtock staves under the lower rigging. Make the topmast rigging similar to the lower, with eyes in the bights, to rest on the cleats, or to pass through the crosstrees, if you have them. Do not strain it too tight or you will pull the lower shrouds and tops out of line. Put on sheer poles and ratlines; keep the latter the same distance apart as those below.

The backstays are of the "running" type, that is, they have an eye over the masthead and are set up with two single blocks each and fastened to eyebolts in the channels.

Blocks are oval bits of wood with grooves round them and holes through them toward one end. The sizes required will be not larger than 3/16, ¼ and ⅜ in.

The main-topmast stay starts with the usual eye and sets up to a deadeye strapped to the fore-lowermast head. The fore-topmast stay has a block in its lower end, and its hauling part starts at the end of the bowsprit, goes through the stay block, through another block strapped to the bowsprit, and belays (fastens) to the center pin on the forecastle.

That is all that may be strictly termed the standing rigging.

Meanwhile, those who have finished this much before the next installment may make the base to stand the model in and fix the boat, guns and the like in position. The boat is lashed down to four ringbolts in the deck near the corners of the hatch. Suitable rings for ringbolts are found in fishing tackle stores. The staple parts can be made from black glass-headed pins, which are soft enough to be bent into a loop, yet stiff enough to be hammered into the wood.

The next and final installment will describe the running rigging, sails, and finishing touches.

Books on Woodworking

READERS who have taken up woodworking as a hobby but did not have the benefit of manual training instruction at school when they were boys, often ask for a general handbook on woodworking. They say that they are sometimes puzzled by questions which they could answer themselves if they could consult a good reference book. There are many excellent books on this subject, among them "How to Work with Tools and Wood," $1, "Essentials of Woodwork and Construction," by Charles A. King, $1.08, and "Woodwork for Secondary Schools," by Ira S. Griffith, $2. As a service for readers the Book Department of POPULAR SCIENCE MONTHLY, 250 Fourth Avenue, New York, will supply any of these for the prices mentioned.

By referring to these books, the beginner can solve practically any ordinary problem in construction that is apt to come up in making furniture and woodworking projects.

A definite program for getting ahead financially will be found on page four of this issue.

Home Workshop Chemistry

Simple Formulas that Will Save Time and Money

GLYCERIN is a thick, viscous fluid, sweet to the taste and soluble in all proportions in water and alcohol. It is almost always found in the family medicine chest because it relieves chapped hands. But it has other uses. It dissolves alum, ammonium chloride, ammonium carbonate, benzoic acid, lead acetate, iodine, copper sulphate, sodium bicarbonate, oxalic acid, and other chemicals.

A small, clean rag, moistened with glycerin and placed in a small container, is useful to have in your auto. If the windshield is wiped with this rag, a very thin film of glycerin is deposited on the glass. This prevents the formation of drops of water in rainy weather and therefore increases the visibility through the glass.

Glycerin will also prevent window glass from frosting. For this purpose one part of glycerin is thinned with one part of alcohol and one part of water. A rag is dipped into the mixture and applied to the glass.

Tobacco stains can be removed from cloth with warm glycerin, even when the cloth is colored.

An air-proofing compound to be placed in a tire can be made easily. One application costs from 10 to 15 cents and often lasts the life of the tire. As an example, a bicycle tire, discarded because of air hole leaks twelve years ago, was recently filled with a small quantity of the compound; it has held its air, under constant use, for over four months.

The leak-proof tire compound consists of glycerin, water glass, and hydrochloric acid. For a bicycle tire use 30 cc. of water glass, 25 cc. of glycerin, and 5 cc. of hydrochloric acid; or use 6 tablespoons of water glass, 5 tablespoons of glycerin, and ½ tablespoon of the acid. First mix the glycerin and water glass and stir thoroughly, then add the acid, mix carefully, and stir. Break the big lumps with the stirring rod into tiny granular pieces of a more or less soft texture. When of a uniform consistency, pump the mixture into the tire with a grease gun. For automobile inner tubes use the same proportions, but increase the quantity.

The following label is intended to be pasted on the glycerin bottle:

Glycerin

$C_3H_5(OH)_3$

Keep glycerin in a tightly corked bottle. Glycerin absorbs about 50 percent of its weight in moisture from the air if uncorked.

To relieve chapped hands, rub on a few drops of slightly diluted glycerin. 3 parts glycerin and one part water; and let soak into the skin.

Wiping a windshield with a rag dipped in glycerin will keep it free from raindrops. Glycerin diluted with equal parts of water and alcohol will prevent glass from frosting.

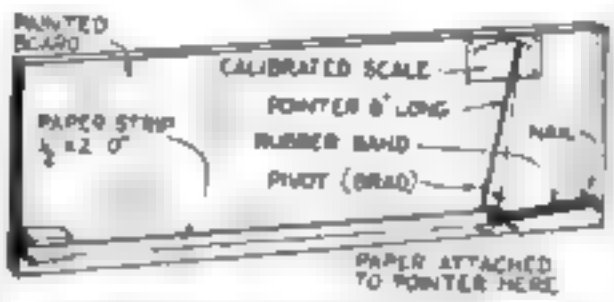
An air-proofing tire compound is made of 30 parts of water glass, 25 parts of glycerin, and 5 parts of hydrochloric acid.

Tobacco stains can be removed even from colored fabrics with hot glycerin.

Paper Strip Indicates Moisture in the Air

IT IS often desirable to know the relative moisture in the air in order to be able to determine approximately the time necessary to dry photographic prints and, no doubt, for many other purposes. I have found that the very simple homemade hygrometer illustrated is a trustworthy indicator in this connection. All that is necessary is a rubber band, a narrow wooden or thin metal pointer about 8 in. long, a small wire brad, and a long strip of good rag-content writing paper.

The apparatus should be mounted on a well-painted board or any other suitable



A simple hygrometer, the actuating member of which is a strip of rag-content paper

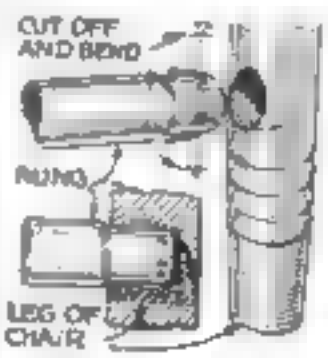
material that is not greatly affected by moisture. Make a hole through the pointer at the base about ¼ in. from the end and just large enough to fit the brad.

As near the lower end of the pointer as possible attach the rubber band and one end of the paper strip so they will pull against each other in opposite directions. The other end of the rubber band should be fastened to the mount so that a slight tension will be exerted on the pointer when the other end of the strip of paper (preferably 2 ft. long) is pulled out until the pointer stands approximately at right angles to the line of band and paper.

The sharp end of the pointer will cover a range of 1½ or 2 in., and a scale may be drawn and calibrated after observing the action over a period in which extremely dry and extremely wet weather are encountered. E. N. MUSGRAVE.

Repairing Loose Chair Rungs

WHEN the rung of a chair has become so loose that regluing is not sufficient to make it hold securely, a repair can be made by inserting a nail or a piece of wire through the tenon of the rung as shown. Drill a hole through the tenon as near the end as possible. Through this push the wire or nail, which should be cut off and bent as indicated. When the rung has been glued and pushed into place the wire ends hold it.



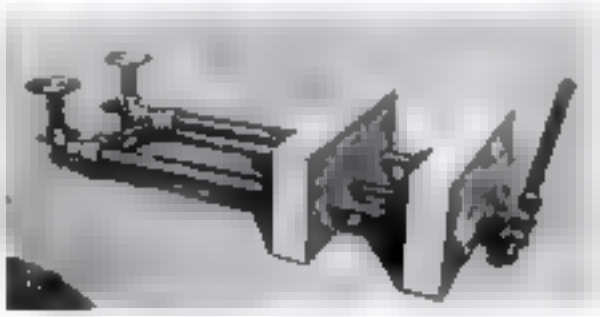
The nail keeps the rung firmly fixed

Regular rung fasteners are made for this purpose and do not require the drilling of any holes, but if they cannot be obtained the method outlined will serve the purpose almost as well.

Homemade Vise Has Guide Bars Made of Pipes

A STRONG vise is a necessity in any home workshop. In the accompanying illustrations is shown how I constructed an exceptionally substantial vise with a framework of pipe and pipe fittings.

First one should obtain two hard, close-grained blocks of wood for the vise jaws. These are bored at each side for the ¾-in. guide pipes and in the middle to take the steel vise screw, which can be bought complete with nut, flange and handle at



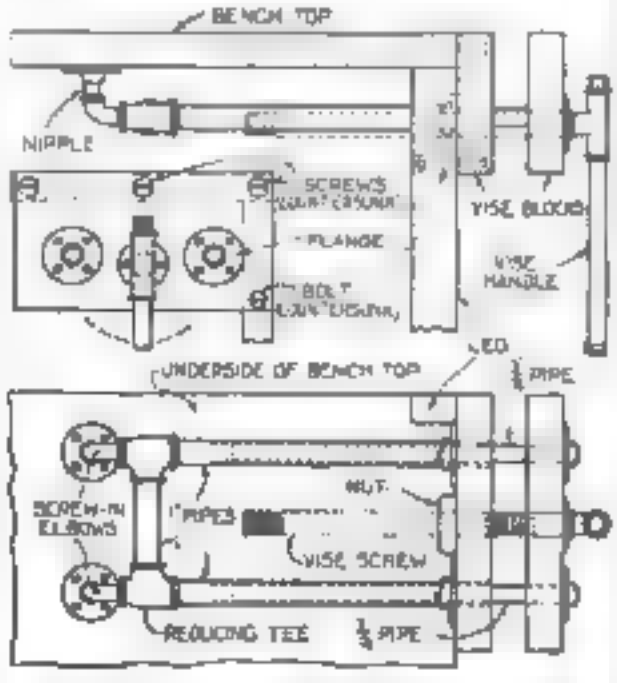
A heavy-duty woodworker's vise with guides to insure the parallelism of the wooden jaws

any large hardware store. The holes in each block should correspond exactly so that the movable jaw will slide easily.

The two guide pipes are threaded on one end and screwed into floor flanges, which are fastened to the front of the movable block. These may be made secure with pins, and a peg can be inserted in the open ends of the pipes.

The guide pipes slide in two 1-in. pipes that are fastened to the back of the stationary jaw by means of flanges and braced at the back by a short cross pipe and two flanges screwed to the underside of the bench top, as shown. The two tees screwed in the ends of the 1-in. pipes are of the type that has two 1-in. outlets and one ¾-in. outlet. A screw-in elbow and small nipple are used to connect the outlets with the flanges fastened under the bench top. All pipe dimensions are, of course, inside diameters.

The vise screw is assembled in the usual manner. The flange is screwed to the front block, and the nut to the back of the stationary block. The stationary jaw is fastened to the edge of the bench top.—WILSON G. WALPERS.



Side, front and under views of the vise showing how it is assembled and fixed to the bench

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Dick Byrd—Adventurer

(Continued from page 3)

obscure than Richard Byrd without his plane.

Indeed, so prominent is Byrd today as the scientist and air navigator that few know of the apprenticeship he served as a thrilling prelude to his later triumphs, an apprenticeship that classes him today with Commanders Towers and Read and Whiting, noted pioneers of naval aviation.

He took the usual seaplane course, taxied up and down the Bay with an instructor; flew with dual controls; tried a few landings, learned to judge distances by seeing how close he could bring his machine down near a buoy, and all the rest of it—but never without an instructor.

The great day came for his solo flight.

WITH taut lips and a heavy grip on the stick he left the seawall, "gave her the gun" and was up. For a good five miles he flew straight ahead. At last he was alone. The great man-built bird that carried him responded to the slightest touch of his hand. He held his breath and tried a turn.

He glanced tremulously over the side of his fuselage. Below him twinkled the blue waters of the Bay. On one side lay the sun-bleached station, its buildings flattened by his altitude; on the other the beckoning sea—the Atlantic Ocean which he hoped some day to fly.

Down he came. He'd done it a dozen times before with an instructor. But this was different. He flattened out a little too soon, losing flying speed, his plane dropped a dozen feet with a crash.

Hell-o! he muttered. "Now watch this next one."

Again he "gave her the gun," watched her speed rise, her body "lift to the step"—that is, to the wave crests. Roar of the engine, still fairly new to his ears, somehow added to his intense concentration on the job of getting his plane into the air.

He drew back his stick. The last throb beneath told him he was clear. Ah, up again!

Joyfully he glanced up and ahead. His tanned face blanched at what he saw. Right in front, not fifty yards away and coming directly for him at top speed, was another seaplane in the act of landing; another student, it turned out later, like Byrd so concentrated on the job in hand that he had no eyes for *neighboring traffic*.

FRANTICALLY Byrd threw his control up. He knew if he could prevent the bottom of his fuselage he might cushion the impact. But he was too late. With a fearful crash the two machines met in midair. Splinters flew. A burst of smoke spouted from the shattered engines. The next instant the locked planes plunged into the Bay.

Before the rescue boat arrived the two student flyers, pale with fright and bleeding from a score of wounds, struggled to keep their heads above water. Soon willing hands pulled them out. Both lived to tell the tale. And both had learned that death was lurking just around the corner for the unwary pilot.

Two months later, in early 1918, he'd won his wings. And on the same day he outlined a great scheme to his superiors. An explorer must sell his plans to his backers.

"If you will let me take one of our big Navy planes across the Atlantic by air and deliver it to our commander in the war zone, it is found to have an effect on the enemy's morale."

As has so often happened in the annals of exploration, the backers were at once enthralled by the idea—only later to be thwarted by circumstances beyond their control.

Byrd was sent to Halifax with a handful of officers and men to establish a base, supposedly for patrol against submarines by air. In truth, the men and the base were the first move in carrying out Dick Byrd's great scheme to conquer the Atlantic and stun the enemy by one triumphal flight.

But some Washington doubters protested.

"How about navigation? Can't do it as you do in a ship. Plane goes too fast. By the time you've got your sight worked out you aren't there any more. And if you make a crooked course your fuel won't last."

Byrd met his critics by an acid test. He devised a special sextant for use in a plane, evolved a new and shorter method of computation in his plane's cockpit, and installed two special compasses of his own choosing. With [illegible] he headed out to sea for the first authentic flight in an airplane out of sight of land.

EVEN his closest friends were anxious. "We knew he'd go out as far he'd have to navigate to get back," one told me. "If his navigation failed he'd drown long before we could find him. Besides it was war."

Byrd's navigation didn't fail. But the unexpected happened—as so often does to the pioneer—adding one more lesson again to the long and thorough training of our man. Fog came. Wind changed. Darkness began to fall. No ship, no stars, dead reckoning thrown out. Fuel running through the exhaust. It looked as if Washington critics were to be justified on the first test.

But the compasses worked. Byrd's ingenious compensation to counteract effect of the metal in his plane proved magically accurate. He steadied on his course back to his base and went roaring through the early antarctic night. His fuel gage fell lower and lower. But he did not falter. His engine began to miss. He closed his throttle and dipped toward the sea. The great test was at hand. In the gray dusk he landed. If he were wrong he should drift and die. If right—

"Boat ahoy!"

A launch from his own base! Dick Byrd had proved for the first time in aviation history that air navigation was practicable.

The Armistice—uncontrollable circumstance—thwarted his plan to deliver a Navy plane direct to our commander in Europe.

Still a new phase in his learning to be an explorer began about this time and lasted for three bitter years.

"YET I think they were the most useful years in my life," Byrd says today, "for they taught me the true meaning of disappointment."

They began, of course, with the Armistice. But the Navy went ahead and built three NC flying boats fit for ocean flight. Each of these huge aircraft had a speed of seventy-five miles an hour, a gross weight of 25,000 pounds, four engines, and a crew of six men. They were intended to be flown across the Atlantic via Newfoundland and the Azores, with a naval patrol beneath them of more than 200 vessels.

Commander Towers, senior of the little squadron, chose Byrd first of all to go with him on that historic trip. But in Newfoundland Byrd was detached with others who had had foreign service in the war, in order to make way for those who had been forced to stay home. This was the first blow.

Then he was ordered to the *C-5*, a small dirigible, to take her across the Atlantic. Two days later the *C-5* was blown away and never heard from again.

In despair Byrd returned to Washington. The NC boats got safely to the Azores, though two landed in the water. One, the *NC-4*, went on to Portugal.

"But that isn't a real flight across the ocean," pleaded [illegible] (Continued on page 181)

Dick Byrd—Adventurer

(Continued from page 120)

Byrd of his superiors; "the long patrol and the two stops on the way. Let me take a plane all the way from New York to Paris.

He is a tenacious fellow when he starts. By the end of a week Byrd had the permission of the Bureau of Navigation and Engineering, Admiral William A. Moffett, head of naval aviation, and his immediate senior in Bureau of Operations, all of whom approved his plan for a nonstop flight to Europe. There only remained the Secretary of the Navy.

Denby was away. Theodore Roosevelt Jr., was acting secretary. He asked Byrd to give up his plan.

"Wait until we have gone further with this flying business."

"But why wait when such a flight would do so much for aviation in this country?" persisted Byrd.

True, public interest in flying had slumped enormously right after the war.

ROOSEVELT'S official manner left him. He stepped out from behind his desk and faced Byrd, man-to-man. His hat clenched as had his father's before him to emphasize deep feeling.

"We don't want to lose you, Byrd. If you say you must go, I will give you permission. But I want you to know that I oppose the idea for the reason that we have not got an engine yet that we know will fly three thousand miles. When we shall have such an engine I am going to help you in every way I can."

These words and the earnestness with which they were said persuaded Byrd not to go. Colonel Roosevelt no doubt saved the young flyer for the greater feats of today. And true to his word, Roosevelt unstintingly gave the young flyer time and energy and money in 1927 to help his close friend, Dick, get properly started to Paris.

The Department solved Byrd's disappointment with orders to the *ZR-3*, the big dirigible then being built in England for the United States. In August, 1927, he hurried abroad to join her and help fly her back.

He reached the British air station the night before the trial flight, too late to be included in the test crew.

At dawn the huge airship was taken out of her hangar. Enviously Byrd watched his friends climb aboard. His last minute efforts to secure a place had met only a curt refusal.

ROSY rays of the rising sun painted the shining body of the dirigible a blood-red, an omen of death, it proved, for shortly afterward, at an altitude of 1,800 feet, the craft suddenly gave forth a loud tearing noise which could be heard over the whole countryside. She then broke cleanly across her middle. A loud explosion followed and she burst into flames while the bodies of her crew came hurtling down to instant death.

Wherein Byrd learned another great lesson; the ruthlessness of fate in dealing with the pioneer.

Now, as so often happened in the midst of a man's most crowded years, Byrd found himself in a swirl of new events, infinitely more vital and personal. He married his boyhood sweetheart, Marie Ames of Boston and Winchester. Children came—one, two, three, four in blithely rapid succession, budding roses in the garden of a young man's youth and love. Yet, the older love was not to be denied—much as he adored his wife and babies, Dick Byrd found the wild was calling still.

Moreover, he was now ready to perform his first big act upon the vast stage of exploration.

Next Month—Commander Byrd's adventures in the Far North, and his spectacular flight across the Pole.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 6.

Huge Flying Hotels Race For First Overseas Flight

(*Continued from page 88*)

construction have beset them the last few months. Their air liner is to be about the size and gas capacity of the *R-100*, but will be capable of a nonstop flight of 7,200 miles. It will have twenty double-bed cabins, a big saloon and dining room, lounges, and "complete hotel facilities." A new gas—etanogas, a carbohydrate of the same weight as air and said to be cheaper than gasoline—will be its fuel.

The *LZ 127* has been designed for a regular passenger route between Seville, Spain, and Buenos Aires, a fifteen-day run by steamships but only a three-day cruise for the air liner. Its builders say it could circle the globe in thirteen or fourteen days, making stops for fuel at Vladivostok, Vancouver, B. C., and Los Angeles.

THE British are making less extravagant claims for the *R-100*. They talk confidently of her first flight to New York and of her return, and then of a regular trans-Atlantic service that will be a part of a world-wide air passenger system—an imperial airship service from London to Egypt, India, Australia, South Africa, New Zealand, and Canada.

Airship bases are being erected in Egypt and India, South Africa and Canada at this moment. Others are in projection. On its first trip the *R-100* will moor at the Navy mast at Lakehurst, N. J., or at the big mast going up at Montreal.

In the proposed schedule for the *R-100*, New York will be thirty-eight hours from London, Bombay fifty-two; and South Africa, eighty. Australia will be seven days from New York, via San Francisco.

What a vista this opens for the summer tourist! Even with only a two-weeks' leave of absence the vacationist can spend ten days in Europe. Four hundred dollars pays for passage in a four-berth cabin. Five hundred dollars buys a two-berth cabin, and a cabin for one can be had for $600.

Has the dirigible proved itself capable of these long distance flights? We will review its history and see.

Before the World War airships in Germany carried 40,000 passengers without a mishap. Immediately after the war the Germans operated an airship line between Berlin and the Zeppelin factory at Friedrichshafen, and 101 flights were made in the 103 days of its operation.

DURING the war the German rigid *L-59* flew without a stop from Bulgaria to Central Africa and back, a distance of 4,225 miles.

In 1919 the *R-34* crossed the Atlantic, London to New York, refueled and flew back. The *Norge* flew from Rome to England, to Russia, to Norway, and across the North Pole to Alaska, a total of 6,200 miles through the temperate and frigid zones.

The ill-starred *Shenandoah* had flown a total of 90,000 miles before she was destroyed. She made one 9,000-mile trip from Lakehurst, N. J., to Fort Worth, Texas; to San Diego, Calif., and to Seattle, Wash., and returned to New York.

The *Los Angeles* has flown 10,000 miles without a major accident. She crossed the Atlantic from Germany in 1924, a distance of 5,060 miles in eighty-one hours. Her last long flight, from New York to the Panama Canal and back, was made between a Sunday and Friday—4,000 miles—at an average speed of fifty-seven miles an hour.

To be sure, this history must consider the disaster of the American-built and operated Navy dirigible *Shenandoah*, broken in two by a storm over Ohio. (*Continued on page 125*)

Statement of Ownership, Management, Circulation, etc., required by the Act of Congress of August 24, 1912, of Popular Science Monthly, published monthly at New York, N. Y., for April 1, 1926. State of New York, County of New York, ss. Before me, a notary public in and for the State and county aforesaid, personally appeared Sumner N. Blossom, who, having been duly sworn according to law, deposes and says that he is the Editor of Popular Science Monthly and that the following is, to the best of his knowledge and belief, a true statement of the ownership, management, etc., of the aforesaid publication for the date shown in the above caption, required by the Act of August 24, 1912, embodied in Section 411, Postal Laws and Regulations, printed on the reverse of this form, to wit:

That the names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Popular Science Publishing Co., Inc., 250 Fourth Avenue, New York, N. Y.; Editor, Sumner N. Blossom, 250 Fourth Avenue, New York, N. Y.; Managing Editor, Raymond J. Brown, 250 Fourth Avenue, New York, N. Y.; Business Manager, [illegible], 250 Fourth Avenue, New York, N. Y. 2. That the owners are: Popular Science Publishing Company, Inc., 250 Fourth Avenue, New York, N. Y. Stockholders of Popular Science Publishing Company, Inc.: [illegible], William Street, New York, N. Y.; Oliver B. [illegible], 250 Fourth Avenue, New York, N. Y.; Robert Cade Wilson, 65 Springfield Avenue, Summit, N. J.; Ada D. Wilson, 65 Springfield Ave., Summit, N. J.; [illegible], N. Michigan Ave., Chicago, Ill.; [illegible], Fourth Avenue, New York, N. Y.; Godfrey Hammond, 250 Fourth Avenue, New York, N. Y.; Sumner N. Blossom, 250 Fourth Ave., New York, N. Y.; [illegible], 250 Fourth Ave., New York, N. Y. 3. That the known bondholders, mortgagees, and other security holders owning or holding 1 per cent or more of the total amount of bonds, mortgages, or other securities are: None. 4. That the two paragraphs next above, giving the names of the owners, stockholders, and security holders, if any, contain not only the list of stockholders and security holders as they appear upon the books of the company, but also, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting, is given; also that the said two paragraphs contain statements embracing affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner; and this affiant has no reason to believe that any other person, association, or corporation has any interest direct or indirect in the said stock, bonds, or other securities than as so stated by him.

Signed: Sumner N. Blossom, Editor.

Sworn to and subscribed before me this 22nd day of March, 1926.

Bertha Hirsch, Notary Public, New York County. New York County Clerk's No. [illegible]. New York County Reg. No. [illegible].

(Seal.) My Commission expires March 30, 1926.

Huge Flying Hotels Race For First Overseas Flight

(Continued from page 122)

in 1925, and destroyed with a loss of fourteen men. And the fate before that of the German-built, French-operated military dirigible *Dixmude* lost in a storm over the Mediterranean. And that of the Italian-built, American-operated *Roma*, military dirigible, which, forced down by rudder trouble, struck a high tension wire and burned when the hydrogen in its gas bags exploded. There have been costly errors in construction and operation of the first great ships. But the builders have profited by all these mistakes.

Each disaster has taught a new lesson. The *Shenandoah*, it has been said, could have flown around or above the storm that was her ruin, had her officers had radio weather reports such as are now available to aerial navigators. In the recent trip of the *Los Angeles* to the Canal, the U. S. Weather Bureau kept the ether crackling with radio reports to the dirigible's chart room!

The designers will admit that the earlier ships were of too light construction. Military-minded, they aimed for minimum weight, that the dirigible could attain a maximum height and thus avoid antiaircraft gunfire. Now, aiming at peace-time commercial navigation, they are building the air giants as sturdy and strong as mechanical science can make them. Commander Charles E. Rosendahl, commander of the *Los Angeles*, asserted recently that this ship is already out of date in the light of present engineering knowledge.

WHILE England and Germany are building their great air liners, our own nation has been marking time. But the signs are hopeful again. Edsel Ford, president of the Ford Motor Company, revealed a few weeks ago that he and his father are investigating metal dirigibles and their possible use for ocean passenger service.

Congress has authorized the construction of two new dirigibles for the Navy, each of them three times the gas capacity of the *Los Angeles* and twice as long. Present plans provide that each ship will carry a hangar large enough for four service airplanes. These will be military ships entirely, but it is probable that their advent will bolster up public confidence in the safety of the big rigids, and certain it is that the arrival of the *R-100* will give a new impetus to American airship construction.

The first steamboat plowed its way through the water in 1807. The public wouldn't believe that steamers ever would cross the Atlantic. Twelve years later the little *Savannah* steamed proudly into Liverpool from New York harbor, just as a learned lecturer was telling his audience that such a thing was impossible!

Indian War Temple Restored

MUSIC, dancing, and the sacrifice of a black hog recently marked one of the strangest celebrations ever held—a jovial party in which grave scientists of the Carnegie Institution mingled with full-blooded Maya Indians. The occasion was the completion of the restored ancient Maya "temple of the warriors," near Merida, in the Mexican province of Yucatan, where the archeologists have finished months of work studying and restoring the temple and have dedicated it to the modern descendants of its original builders.

The scientists believed the example of the great white structure built by their forefathers would inspire the Mayas to great deeds. Therefore, with the cooperation of the Mexican Government, they gave a great party for the tribes. Native women in their best "huipiles," carrying babies, and men in white cotton pajamas, came from villages for miles around.

$200,000,000 for Research

Continued from page 51

that four or five coats of paint and as many as a dozen of varnish used to serve. Now the automobile maker can deliver the finished car within twenty-four hours after construction is completed, and that is one of the principal reasons why cars now are cheaper than they used to be.

Not all scientific discoveries are the result of deliberate search—sometimes they occur by accident. To research chemists the lacquer problem seemed hopeless at one stage because the liquid persisted in setting into a jelly. A breakdown of apparatus forced abandonment of one experiment. In a few days the jelly of its own accord turned fluid—just the consistency desired.

PHONOGRAPH records are made by stamping disks with copper electrotypes of the original records. Once a batch of electrotypes was found harder and more durable than usual. They would stamp more records. Chemists analyzed the chemical mixtures used in making the electroplates and found a foreign substance. A workman eating his lunch, had accidentally dropped a bit of cheese into the mixture. Now casein, an essential constituent of cheese—is regularly used, reducing the cost of making records.

Scientists were seeking something to add to gasoline to prevent knocking in an automobile motor. One thought color might have some relation to the problem. Out of ten thousand chemicals that had some color or other, the storekeeper handed him—at random—iodine. It worked!

Of all the subjects occupying the attention of scientists today, that of radiation of all kinds is in the first place. As a result of the investigation of light from the sun, it was found that there are two kinds of light rays which are invisible to the human eye: ultra-violet and infra-red. Ultra violet rays cause sunburn, and now physicists, chemists, biologists, and dietitians, working together, have discovered that they germinate the vitamins in our food which are essential to health. Hundreds of practical applications of the ultra violet rays have already been developed. By exposing different kinds of food to ultra violet rays, either in direct sunlight or under specially designed electric lamps, their nutritive qualities are greatly increased. The growth of young animals and plants is speeded up in the same way and many forms of nervous diseases and illness due to improper nutrition are relieved.

AND now the chemists have found a way of making window panes through which the ultra-violet rays will pass. Few if any will go through ordinary glass, but 92 percent will go through sheets of fused quartz glass, which is now obtainable for about a dollar a square foot, and through some patented glass substitutes. Anybody can have, at a cost of ten or twelve dollars, a south window through which these life-giving rays will penetrate, and so can take a daily sun bath even in mid-winter. One big office building in New York has at least one quartz crystal window in each office.

The infra-red rays have no effect upon the surface of the body, but penetrate into the deep tissues and, generated in another type of electric lamp, are now being widely used to relieve rheumatism and other deep-seated pains.

Scientists working in the realm of botany have probably contributed more dollars and cents value to the human race than those in all other lines combined. As a result of their research and its application to agriculture, production of foodstuffs in America has increased fifty-eight percent while population was increasing only forty. Modern methods of seed selection have increased the average yield of potatoes by nearly fifty bushels to the acre. In Canada, where the growing season between frosts is short, the development of a wheat which would ripen in ten days less time than the former standard varieties has added hundreds of millions to the value of wheat lands.

Astronomers studying the solar spectrum discovered indications of an element unknown on earth, which they called helium, meaning derived from or related to the sun—a gas a little heavier than hydrogen but less volatile and lighter than any other known substance. This set geologists to hunting helium in the earth. In the natural gas from certain wells in Texas a chemist who had been called in by the geologists found a material percentage of helium. Now engineers have devised ways of separating the helium from the other gas by use of another purely scientific discovery, liquid air, the coldest refrigerant known. So we have helium, the nonflammable gas for filling dirigibles in place of the highly inflammable hydrogen.

And experiments now look toward the possibility of producing helium synthetically from hydrogen. This would be accompanied by such a release of atomic energy, the physicists say, as to furnish the world with an almost inexhaustible source of power. Then the energy generated from a teacupful of water would drive the *Leviathan* from New York to England and back.

It was Professor Dewar's discovery of liquid air which resulted in the invention of the thermos bottle. Dr. Dewar, seeking for some way of carrying liquid air from his laboratory to a lecture hall, conceived the idea of a vessel with vacuum walls to insulate against heat and cold. The familiar vacuum bottle which nearly everyone uses is the result.

A GERMAN scientist discovered that a mixture of iron rust and aluminum powder ignited, would fuse at a temperature of nearly 5,000° Fahrenheit. This mixture, known as thermit, has been used for a number of years for welding together broken parts of steel machinery. Now a professor at McGill University, at Montreal, has discovered a way of keeping that harbor and others navigable the year round with thermit. Sudden application of intense heat at or near the center of an ice field starts crystalline fractures throughout the entire field. A comparatively small amount of thermit, ignited in the middle of Montreal's harbor, broke up of the entire field into small blocks through which a ship could safely navigate.

One of the most important fields of scientific research today is the study of corrosion in metals. Here is an example of results. Duralumin, the lightweight metal now extensively used in the construction of airplanes, corrodes when exposed to sea water or salt spray. Physicists of the U. S. Bureau of Standards found that by coating the surface of duralumin with a thin film of pure aluminum, which does not corrode, the problem was solved; and engineers quickly invented a process of spraying melted aluminum over the duralumin surfaces.

ANOTHER metallurgical problem solved by the Bureau of Standards was to devise a silver alloy for making coins which would not tarnish, but always remain bright. They did this by alloying the silver with cadmium instead of copper, producing a metal which will not turn black even when exposed to sulphur fumes. This research, adapted to jewelry and silverware manufacture, has proved to be more than worth its cost.

Dollars and cents from science! Practical service to humanity! No wonder industry is putting the ablest young professors and graduate students to work in great research laboratories to see what else they can discover.

Taming the Mississippi

(Continued from page 61)

brings up a new problem—or rather, another part of this same one. Channels must be provided for this flood water from spillways, so that it can reach the sea, or eventually get back to the main stream. That is where floodways come in."

Here, Prof. Lane explained, the old formation of the Mississippi valley can be used to good advantage. The lowlands at the sides of the valley form natural watercourses. By utilizing rivers and streams already in existence, cutting occasional channels here and building new levees there, floodways can be provided that will parallel the Mississippi itself, taking some of the surplus water from the spillways safely down to the sea.

"Spillways and floodways," said Prof. Lane, "will take years to complete. And even that will probably not fully solve the problem.

"As far as plans for great reservoirs in the lower Mississippi valley itself go," he said, "they sound to me pretty impractical. The Mississippi basin is so great that excessive rainfall in even one fifth of the total area will cause a flood. If unusually heavy storms occur in Illinois, Indiana, Ohio, and western New York and Pennsylvania, there is a Mississippi flood. If Iowa, Kansas, Nebraska and Missouri have heavy rains, there may be just as great a flood.

Now, suppose there is an extra two inches of rain in Minnesota, the Dakotas, and Iowa. To take care of even that much additional water, over that limited portion of the Mississippi valley, would mean a reservoir as big as Connecticut, with water eight feet deep."

IT MIGHT be practical, however, to provide for reservoirs of a somewhat different nature. Prof. Lane explained.

Certain areas could be made 'emergency districts' to accommodate flood waters. They could be farmed during years of low water but they would have to be cleared of permanent homes and all resident population. People required to move out might be compensated by state or nation.

"Another new type of reservoir could be created where the main tributaries join the Mississippi. The angles between the two streams could be allowed to overflow, making a series of triangle-shaped flood reservoirs."

But Prof. Lane was not through. "I have left the most important thing of all," he said, "until the last. Levees, spillways, floodways, and emergency reservoirs could all be rendered useless by a really great flood such as that of 1783. Eventually, the flood water must be controlled at its source."

This was amazing. "But how can it be done?" I asked.

"The simplest thing in the world," he answered, "only it will take time. Incidentally, it will take a lot of money, too—although the money will prove a good investment and pay real dividends, quite aside from the saving in flood damage. Power reservoirs are the final answer to the Mississippi floods.

"In the future, Mississippi valley floods will be prevented by the control of a sufficient amount of flood water in power reservoirs far up along the tributaries. Each reservoir will have an emergency capacity which cannot be filled except as a flood control measure. Let us say the normal water level will be two feet below an emergency level. Then in times of flood the reservoirs will be filled to emergency capacity. Water can be held back from the Mississippi through a dozen states, while the flood waters of half a dozen more are being accommodated. The water held back may be worth for power the extra cost of the emergency dams of the reservoirs.

"Those dams—hundreds of them—are the real answer, but until enough are built levees, spillways, floodways, and emergency reservoir areas will give partial relief."

Galileo Galilei, An Immortal Fool

Continued from page 35

who could not see the error of their old beliefs. And Galileo's new position gave him the chance to knock in the head some of the prevalent notions of physical laws. One of these, part of the accepted theory of moving bodies, was that the speed of a falling stone depended on its weight, the heavier the stone, the quicker it would reach the ground. To Galileo this was absurd; he could disprove it by the simplest experiments; he chose, however, to stage an impressive public demonstration.

Summoning a great crowd of professors and students beneath the famous leaning tower of Pisa, the young professor dropped from its top two stones, one large and heavy, the other small and light. To the astonishment of the throng, the stones fell side by side and hit the ground at almost the same time, whereupon Galileo demonstrated that the slight difference in time of descent was due entirely to resistance of the air. Whether they realized it or not, the spectators witnessed, in that experiment, the beginning of a new era of scientific knowledge.

TRADITION dies hard, though, even in the face of proof. In his first important victory Galileo aroused a host of new foes whose attacks forced him to resign his professorship at Pisa. But friends obtained for him a position in the University of Padua and there Galileo made his greatest discoveries.

There he made the first crude thermometer—simply a tube containing water, the expansion of which indicated the temperature. Later it was improved by replacing the water with spirits, then with mercury.

There, too, Galileo, in 1609, learning that a Dutchman had invented an instrument which made distant objects seem near, undertook to solve the mystery. In a single night, he produced a telescope which magnified three times: a leaden organ pipe with a glass at each end, one glass convex on one side, the other concave. Soon he improved it to magnify eight times, then thirty.

The instrument became the sensation of the day among scientists and laymen alike. Soon everybody wanted telescopes. Galileo, manufacturing the instruments in his small workshop, could not supply the demand.

NOW, turning his new spyglass on the night skies, he found wonders never dreamed of. The surface of the moon, instead of being smooth as everyone thought, revealed high mountains and deep valleys. The glowing haze of the Milky Way showed myriads of separate stars which might be counted. Around Jupiter were four little moons, or satellites, rotating on regular courses.

Incredible! Did not everyone know that the earth was the center of the universe; that the stars were fixed like jewels on a vast surrounding sphere, all at equal distances from the earth? Yet now Galileo claimed to count ten times as many stars as had ever before been seen. What could this mean except that the new stars were more distant objects suddenly brought into view?

The discovery of Jupiter's satellites added strength to the new and bitterly assailed theory of Copernicus that the sun, and not the earth, was the center of the heavenly system; that the earth rotated on its axis once a day and revolved around the sun once a year.

To astronomers, teachers and religious men of the old school, all this was unbelievable and blasphemous. From all sides they began to level ridicule and insults at Galileo. To explain away Jupiter's satellites as mere phantom images in the telescope caused by reflected light, one professor at

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A definite program for getting ahead financially will be found on page four of this issue.

Galileo Galilei, An Immortal Fool

(Continued from page 126)

Padua said, "We know that there are only seven metals, seven days in the week, and seven apertures in a man's head, therefore there can be but seven planets."

And even when, looking through the telescope, he was forced to admit the appearance of the satellites, he argued that since they were invisible to the naked eye, they were useless and consequently did not exist!

Galileo answered the attacks by extending his observations, discovering, among other things, the presence of spots on the sun, the phases of Venus, and the rings of Saturn.

All the while hostility grew. The upshot was that in 1616, when he was fifty-two years old, Galileo was commanded by religious authorities to cease advocating the Copernican theory on pain of punishment as a heretic. At first he obeyed, but seventeen years later, after publishing his *Dialogue on the Two Principal Systems of the World*, he was summoned before the Inquisition at Rome and sentenced to imprisonment—though the penalty was never ratified.

Kneeling in the sackcloth of a penitent, before brilliantly-robed rulers of the Church, Galileo swore never again to teach that the earth moved around the sun. Then, rising to his feet, he whispered to himself

"*E pur si muove.*"—It does move, for all that!

Putting the Earth on the Scales

(Continued from page 84)

rod, suspended in horizontal position from an exceedingly fine tungsten wire and at each end of the rod is a glass ball. This pendulum arrangement is made to swing back and forth, twisting and untwisting the wire. On opposite sides of the iron case, and as close as possible to the balls, hang the two steel cylinders. The attraction between cylinders and balls affects the swinging time of the pendulum. Thus, when the cylinders are shifted to positions somewhat farther from the balls, the gravitational attraction is correspondingly lessened, and the time of swing is changed accordingly. By measuring this difference in time with a moving beam of light on a scale, Dr. Heyl calculates the actual value of the attraction. This value is found to be amazingly small—about equal, he says, to the weight of the ink in one of the printed periods on this page.

YET with this tiny measurement completed, weighing the earth becomes simply a problem in proportion—an application of the result on a huge scale.

Through Dr. Heyl's patient work, the accuracy of measuring gravitation already has been increased ten times.

But of what use is it to know the mass of the earth? Well, for one thing, it has enabled geologists to learn much about the earth's structure. They have found, for example, that its average density is about five and a half times that of water. And since they know that the earth's crust has only about half this density, they can conclude that the interior is far denser—a core of iron, perhaps.

Moreover, it is of tremendous importance to astronomers. Knowing the mass of the earth, they can calculate the masses of the sun, planets and other celestial bodies.

Like a hermit in his cave, Dr. Heyl has spent years of painstaking labor to perfect the most remarkable weighing machine in the world—a machine that now gives us fascinating new knowledge of the strange universal force which keeps our feet on the ground.

Gus Explains a Broken Axle

(Continued from page 70)

the axle, did you? A loose wheel jars the axle badly every time you let in the clutch or put on the brake. In time this breaks the axle—usually at the end of the taper. This time it happened to break near the other end.

"The time to tighten the wheels is after you have driven the new car a few hundred miles. By that time they should seat so solid they won't come loose again.

"The reason the wheel came off is because in your car it is held in place entirely by the axle, and when the axle breaks there's nothing to keep the axle with the wheel on the end of it, from sliding out except the retainers—and they were loose, too. If you had kept the retainer bolts tight, the wheel wouldn't have come off, although if the break had been right at the hub the wheel would have dropped off right away.

"The only cars you can tow, no matter where the axle breaks, are the high priced models that are fitted with real, genuine, full floating axles in which the wheel rides on bearings on the axle housing and the axle does nothing but turn the wheel. The axles they generally call full floating these days are really only three quarter floating."

"It's all too deep for me," sighed the fat man. "Why don't they put in one axle that goes right through from one rear wheel to the other? What good is the differential, anyway?"

"Ever hear a freight train going round a sharp curve," questioned Gus, "and notice that shriek the wheels make? The wheels on freight cars are fastened to a solid axle. If you measured the rails on the curve you'd find the outside rail quite a bit longer than the inside one. That means that the wheel on the outside rail ought to turn faster. The shriek is caused by the wheels slipping on the rails because, being fastened to the solid axle, they can't turn at different speeds.

"When an automobile goes around a curve the outside wheel turns faster. Wheels can slip on steel rails but the rubber tire wouldn't slip on the road and the axle would be twisted in two by the strain. The differential gear lets them turn at different speeds. Did you ever drive a team of horses?"

"I surely have, I was brought up driving horses." The fat man visibly brightened up. "There's nothing you can tell me about handling horses. But what's that got to do with differential gears?"

"Then you know how a whiffletree equalizes the load on the two horses of a team. If one horse starts loafing his side of the whiffletree moves back toward the wagon. A differential gear in an auto is simply the whiffletree idea made up in gears so that the motion is continuous. Of course the action is the other way round. The motor applies power to what would be equivalent to the wagon tongue and the wheels are connected by gears just as though they were hooked to the ends of the whiffletree.

"By cracky! Now I see it," Gus's passenger exclaimed. "That explains why the car won't run if just one of the axles is busted. It's just as though the harness broke loose on one side. Then, of course, the whiffletree would sag back on that end; and if it's gears, instead of a lever like the whiffletree, why you never could get any pull on the wagon tongue!"

"You've got it exactly," smiled Gus. "But remember that even if differential gears work like a whiffletree, you can't treat them like one. Gears wear out unless they're lubricated, so clean out the rear end and put in fresh lubricant once in a while—say about every five thousand miles. Well, here's Cooperstown. So long, we'll be back for you in a couple of hours."

Forts on Wheels Defy Bandits

(Continued from page 48)

resorted to armament. A modified form of armored car has been adopted by the department and is now in wide use in the postal service.

Banks are not the only customers of armored car service. Chain stores, filling stations, theaters and ball parks, any concerns having large sums of money or quantities of valuables to transport, use the armored car as a safety measure.

When the Federal Reserve Bank of New York moved into new quarters, forty-five armored cars carried four billion dollars through busy streets under supervision of the U. S. Secret Service. They hauled 700 tons of gold and silver, to say nothing of huge amounts in paper. Each money car was preceded by a pilot car and followed by a trailer. A hundred and fifty policemen lined the few blocks of the route and kept watch at strategic points near by. Riflemen stood by on the tops of buildings. Secret Service agents swarmed in the streets. No bandit was bold enough to brave that network. The same thing was done in Chicago, where the cargo was $45,000,000.

Armored car crews are taught to make every trip with the expectation of an attempted holdup. The trucking corporations require practice every week in their shooting galleries. There crews fire at the silhouette of a man—and always "from the hip," since it is not expected that they will have time to aim when confronted by bandits.

They fire at two parts of the silhouette—the head and the trunk, and when it is the trunk, they spot the approximate position of the third button from the top of the vest. Necessarily, they are first-rate marksmen. Their scores are kept, and if a man goes below a certain mark for a month, he loses his job.

One company, like others, has assembled a group of exceptional men for its crews. Among them is, or was, a former Russian general, to say nothing of a dozen or more former captains of various armies. Besides these, there is the former commander of a Russian ship who in an encounter with a German submarine was gravely wounded and was nursed by the Cossacks. A nobleman or two have also served on armored car crews.

Every man is bonded for the extraordinary sum of $1,000,000, and every armored car is insured for $1,000,000. The car rarely will not haul a load in excess of the latter amount, as it is always protected.

Since the introduction of the armored car some years ago the business has grown to enormous proportions. The New York concern recently was operating sixty-seven cars, and from its shop, where it manufactures the bodies, was turning out a new one every ten days. The cars have routes, some serving fifty customers in a day. Their whereabouts are known constantly by the dispatcher who sits amidst a battery of telephones, and each can be reached by headquarters within fifteen or twenty minutes at any time.

Despite its billions of business, carried on over a period of several years, the company has never had a holdup, W. R. Huntington, vice president, told me; yet he keeps his men trained to expect one. He was in the express business in the west in the days of Jesse James. In his opinion, bandits then were gentlemanly compared to those of today.

"At least they didn't shoot till they had to," he recalled. "They took the money and went on their way, shooting only as a last resort. Nowadays they first kill their man and then get the money."

Here Are Correct Answers to Questions on Page 60

1. Both the Aztecs and the Mayas must have been good astronomers. The Mayas originally occupied a part of what is now Guatemala. Later they moved to Yucatan. It is probable that offshoots from the Maya civilization greatly influenced the Aztecs. More than 2,000 years ago the Mayas had observed the motions of the stars, the recurrence of eclipses, and the rotations of the phases of the moon. One of the best ancient calendars devised anywhere is that of the Mayas.

2. On the island of Trinidad, off the coast of Venezuela, there are some natural lakes of asphalt or mineral pitch. The crude asphalt is dug out of these lakes, melted to separate it from the dirt, and then is shipped to northern countries for use in paving streets and for roofs and other similar purposes.

3. In 1674 Holland traded the colony of New Amsterdam on Manhattan Island to the English for the country now called "Dutch Guiana" in northern South America.

4. Connecting the towns of Elberfeld and Barmen in western Germany, north of the city of Cologne, there is a famous monorail elevated railway. For a part of its course this railway runs over a river. As a convenient method of construction, the single rail is supported on stilts and the cars of the railway are hung from this rail, just as the package carriers are in department stores.

5. This is a joint result of the great cold of winter and of the absence of mountains. Since there are no mountains, there is nothing to break the winds, and wind and cold are great enemies of trees.

6. Near the western coast of the United States there is the great mountain ridge of the Sierra Nevadas. Five hundred miles east of these comes the other great mountain range of the Rockies. Between these two great mountain walls lies the saucer-shaped Great Basin.

7. Before the Great War a German naturalist found, in what was then German East Africa, some fossil bones of dinosaurs, a variety of very large reptile, long extinct. Some of the bones are as much as seven feet long. The animals themselves were probably nearly 100 feet long. The locality was transferred to Great Britain by the war and is now in Tanganyika Territory, near the town of Lindi. It is being excavated by the British Museum.

8. This is the customary method of growing rice, the chief grain crop of China, Japan, India, and other eastern countries.

9. This is the name of the remarkable wild dog that inhabits Australia. It is one of the few Australian animals not belonging to the marsupial class. Marsupials carry their young in pouches.

10. If one neglects the parts of the earth that are covered by oceans, the lowest spot is the surface of the Dead Sea, in southern Palestine—1,290 feet below sea level.

11. In southern Oklahoma and northeastern Texas there has been a considerable development of natural gas which contains the highest percentage of helium found anywhere in the world.

12. Pure gold is too soft for satisfactory coins. Modern coinage is composed, usually, of alloys of gold, with either copper or silver, alloys that the ancient peoples did not know how to make.

This seal on an advertisement in POPULAR SCIENCE MONTHLY signifies the approval of the INSTITUTE OF STANDARDS. See page 8.

Seventeen-Year Locusts Coming

Continued from page 87

from the size of a flea up to an inch in length.

This spring Brood II has felt the call of the upper atmosphere. Restlessness grips their "souls," and the migration to the surface begins. They are now wearing their pupal "coat," and the rudiments of their wings have appeared. At some unseen signal, up they will come in eager anticipation, thousands and thousands of them. Perhaps some tree or stone will be in their way, and a long detour necessary. Perhaps a house has been built on the site of their childhood home. Consternation and catastrophe—death.

THE more fortunate, deliberate and determined, crawl up any convenient object—a plant, a fence, a tree or a house—and there undergo that remarkable transformation to the perfect winged adult. The pupal "coat," or skin, splits along the middle of the back and across the head, and through this T-shaped aperture the periodical cicada makes its debut, at first pale and limp from this trying process, but quickly coloring and hardening and flying away.

The density of the swarms is often spectacular. Once they completely covered a newly white-washed fence, the pride of its owner. Again, it is said that a party of motorists skidded into a tree on a road literally covered with these insect bodies, some of the riders being injured.

These pranks remind us of the locusts that once covered railroad tracks for miles in a certain locality and demoralized traffic for hours. A rotten sense of humor on the part of our insect choristers and their lecturn wives.

House Starts Life Over

Continued from page 86

copper is available also in shingles and also in strip shingles of asphalt base surfaced with fine metal. The recommended weight in the first two forms is sixteen ounces per square foot. Sheets are more economical than all-copper shingles and may be had in widths of twenty or thirty inches with a length of eight feet. They are fastened by turning the upright lengthwise edges over copper cleats nailed in the roof surface, so there are no nail holes. End joints are crimped and may be soldered, but on the long seams it is sufficient to fill them with white lead before turning over. All details of a copper job, meaning nails, should be of the same metal. Soft copper is prescribed for the roof covering, while gutters and leaders with their hangers should be hard tempered. A green effect, artificially produced, does not last, but anticipates the natural patina that develops in time and is protective rather than otherwise.

Zinc also can be had in shingles and sheet form. Somewhat recently aluminum has appeared in the form of large shingles. It has a distinctive luster and weighs half a pound to the square foot compared with twice to twenty times as much for other substances. Flashings and other roof accessories in aluminum are obtainable.

"This is still a mystery if not a spook house," I observed. "Where is the maid's room and bath?"

"Come down into the basement," laughed the owner. Sure enough, there was plenty of space left below and the maid's neat quarters had the best corner, almost on the outside grade level, with three ample windows in the brownstone walls.

Wholly a fascinating place that old house. With all credit to the modern improvements, I take off my hat to the far-sighted builder of 1812.

A Great Dream Opens an Empire

(Continued from page 86)

the price, there's a way of making it come true. Big or little, the world has room for it. Out where I come from, there are millions of idle acres waiting for men like you. Don't compromise!"

Next day a head waiter at the Belmont received a gift from David H. Moffat a deed to a $15,000 ranch in Colorado. The empire builder broken in pursuit of his vision harassed by difficulties, still had sympathy for another man's dream.

Soon afterward, on March 18, 1911, Moffat, seventy-two years old, died in New York among strangers, his own dream unfulfilled.

The Moffat road went into the hands of receivers. But Denver did not forget the man who had done so much to build it. Engineers at last caught "Dave" Moffat's vision. They saw that his railroad could be operated profitably by boring a tunnel and cutting off twenty-three miles of circuitous climbing.

A GROUP of fighting men decided to raise the money by a state-wide bond issue. Once more there was bitter opposition, but at last the bond issue was authorized by the Colorado Legislature. In 1923 boring began on each side of the Divide. The engineers met and conquered gigantic problems. Much of the boring was through solid rock. Underground rivers were encountered.

A little more than a year ago President Coolidge, touching a golden telegraph key in Washington, set off the blast that opened the first free passage through the tunnel. Workmen from East and West clasped hands, nearly a mile below the summit of James Peak.

The first opening was in the so-called "pioneer bore," an exploring tunnel eight feet in diameter, paralleling the main tunnel and connecting with it by cross-cuts. This smaller tunnel will carry water supply into Denver.

The main tunnel, twenty-four by sixteen feet, enters the Continental Divide fifty miles west of Denver, at an elevation of 9,100 feet. It rises on a 0.3 grade to a peak of 9,239 feet elevation, then drops on a 0.9 grade to the western portal near Irving, Colo., 9,100 feet.

IN ADDITION to two railway tracks, the tunnel will carry telephone, telegraph and electric power lines for the service of the Rocky Mountain section. Automobiles will be carried through on flat cars, avoiding the snow-blocked mountain passes.

The undeveloped territory opened by the tunnel contains enough coal, geologists say, to supply the United States for 1,500 years. Its timber resources are enormous. Immense beds of oil shale, experts say, contain enough oil to supply the United States, at its present rate of consumption, for a thousand years. There are practically inexhaustible stores of marble, millions of acres of rich farming land, range for hundreds of thousands of sheep and cattle, stores of precious metals, and millions of kilowatts of undeveloped water power.

Moffat's railroad, emerged from receivership, is on a strong financial basis. It extends 255 miles westward from Denver toward Salt Lake City. A branch turns southward toward Dotsero, on the Denver & Rio Grande Western, only forty-one miles away. Connection of these lines will complete a new route from Chicago to California, cutting five to six hours off the time schedule. Proposed extension of the Moffat road to Salt Lake City would create still another route, 107 miles shorter than the Denver & Rio Grande, and fifty-six miles shorter than the Union Pacific.

Thus is being realized the vision of the last of America's great railroad pioneers who, when a mountain stood between him and his dreams, refused to compromise but exclaimed "I intend to go through that mountain."

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[illegible] Hundred popular and rare [illegible] New England coastal [illegible] Aero Stamp Mfg. Co., Inc., Detroit, Mich.

[illegible] Instruments. $1.00 each. Chapin Dial Co., [illegible] Angeles.

[illegible] Specialists [illegible] Send for our complete [illegible] Manual. Explains [illegible] Building and Flying Models. Dept. [illegible] Street, Allentown, Penna.

[illegible] Wanted [illegible] Write us [illegible] Action. Specify [illegible] Aviation Supply Co., [illegible] Theatre Bldg., St. Louis, Mo.

[illegible] Plans and Models. Complete [illegible] details and [illegible] Flying Models. [illegible] Cornelius Model Co., [illegible] Ave., Dept. A, Chicago, Ill.

Bending Machines

[illegible] Bending Machine. Universal. Enclosed [illegible] Included in the last [illegible] Bending Machine. Bending [illegible] with or [illegible] Machine. [illegible] Bending) Type Rod and Angle [illegible] Bending. Made up [illegible] Name [illegible] Machine. Write today for [illegible] Machine Co., [illegible] Ave., Cleveland, Ohio.

Boats and Launches

[illegible] 30ft. work boat. Chalmers motor speedster. Fabulous cruiser. [illegible] of all sizes on hand. Boats [illegible] Materials. 35 Models. Send [illegible] for catalog. Brooks Boat [illegible] Co., Dept. [illegible] Saginaw, W. S., Mich.

Books

[illegible] and public [illegible] it to be the best ever produced. Radio Theory and Operating, by Mary Preston Lewis, member [illegible] use of Radio Institute [illegible] on radio. Contains [illegible] and reference book. 500 pages, [illegible] 3 [illegible] prepaid. [illegible] and [illegible] Radio School, Technical [illegible] Chicago.

[illegible] Methods and Secrets. Dept. [illegible] receipt check or money order. [illegible] Publishing Company, Dept. F-40, 10th at Walnut, [illegible]

WANT the Radio Digest should know a [illegible] Booklet with full information on selecting and operating one. Price 5 cents. Popular Science Institute, 250 Fourth Ave., New York.

[illegible] $1.00— Henry Hellman, Box 814, Omaha, Nebraska.

[illegible] magazine and fur farming. Send 10c for 3 months' issues. Hunting and Trapping Magazine, Summit Hill, Ohio.

Business Opportunities

LEARN the collection business. Good income quick profits. Interesting booklet. Stamps appreciated. Free. National Collector's Association, Scheuer Building, Newark, Ohio.

Business Opportunities

[illegible] Art Service. [illegible] Artcraft Building, 6th Avenue at 53rd Street, New York.

[illegible] Opportunities. [illegible] Particulars Free! C. Ellis, 233 South Dearborn, Chicago.

[illegible] Patented Trade Mark Received. A confidential [illegible] counsel promptly. Write for [illegible] Book of Hints for Inventors. Preliminary advice [illegible] Book free. [illegible] Washington, D. C.

[illegible] Magazines, catalogues [illegible]

[illegible] Manufacturer [illegible] Patented [illegible] Company, 241 Pearl Street, Grand Rapids, Michigan.

[illegible] business for yourself. Make $25 daily [illegible] a plan booklet. Free [illegible] Henson Laboratories, 2nd [illegible] Street, New York.

AN OPPORTUNITY [illegible] Small capital sufficient. Learn [illegible] Write for [illegible] Paul Kaye, 1 West 42nd Street, New York.

[illegible] and thousands [illegible] Patterns, Samples for Stamps. John Rubin, Dept. 30, Nora Ave., Chicago.

Chalk Talks

[illegible] Entertainer program. $1.00. Catalog free. Clarendon Studio, [illegible] Minnesota.

Chemicals

[illegible] New catalog. Send for 5000 chemicals, Glassware, Books, [illegible] Supplies. Send for [illegible] receipt of 5c. Laboratory Materials Company, 845 East 21st Street, [illegible]

[illegible] of experiments and chemical catalogue. [illegible] Chemical Laboratories, Newton, Penna.

[illegible] Specimen Minerals. Three [illegible] Price [illegible] Other models. Write. Scientific Specialties Co., Madison, Wis.

Correspondence Stationery

250 LETTERHEADS and 100 Envelopes, $3.10, postpaid. Oberman Company, Box 1288, Chicago.

Dogs, Birds, Fish

BEAGLES [illegible] registered bull pups, $15. Bulldogs, 101 Rockwood, Dallas, Texas.

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[illegible] for any Civil Service examination, [illegible] Write at once for free catalogue. Columbian Correspondence College, Washington, D. C.

[illegible] a short [illegible] course in Engineering, [illegible] with a [illegible] guaranteed diploma. [illegible] Engineering, Drafting and Shop [illegible] Springfield, Ohio.

[illegible] Make $[illegible] a week as Detective in Secret Service. [illegible] Write at once for free [illegible] particulars. [illegible] Detective, Dept. [illegible] Indianapolis, Indiana.

[illegible] experts earn $3000 to $5000 annually. Study [illegible] Fascinating, [illegible] Degrees granted. [illegible] free. [illegible] principles of all [illegible] at Home. Write for free [illegible] College of Mineralogy, 721 Lakeside Ave., Hammond, Ind.

Engines—Motors—Dynamos

MAKE Electric Motors. Half and one horse-power. A [illegible] motor in Shop of Wrinkles models show [illegible] time plan. [illegible] Learn quick way. Dept. 5, Cadmus Press, Chicago, Ill.

Financing

[illegible] and Inventor You Business. Need Special Secretarial [illegible] Brokerage Company, 145 N. Clark St., Chicago, Ill.

For Electricians and Helpers

THE Electrician's Wiring Manual, by [illegible] Rapp, gives [illegible] all the [illegible] for the proper [illegible] of [illegible] and [illegible] in Houses and other Buildings. [illegible] Complete, up-to-date [illegible] and [illegible] on the [illegible] with the National Electric Code. Price $7.00. Popular Science Monthly, 250 Fourth Ave., New York City.

For Inventors

[illegible] Ideas Can be Sold. Let us tell you how and help you make the sale. Free [illegible] Write W. T. Greene, 815 Bacon Building, Washington, D. C.

[illegible] Commercialized. Patented or unpatented. Write Adam Fisher Mfg. Co., 130 Enright, St. Louis, Mo.

[illegible] to work in their own [illegible] and [illegible] Spare time or [illegible] Write Manufacturers, 1560 Broadway, New York.

[illegible] Ideas Wanted. Inventions [illegible] Mechanical Movements [illegible] Patented. Outfit Free. Tells How to Obtain And Sell Patents. Presents a New Idea, Its Value, How to Select Your Attorney, and Avoid Delay. Sent Free. Prize $1000 Guarantee. Albert N. Dieterich, 624 F, Adams Building, Washington, D. C.

[illegible] Has [illegible] to decide [illegible] the right [illegible] Write [illegible] Invention Service, [illegible] Building, Washington, D. C.

[illegible] Patents. [illegible] Patented [illegible] Charles A. Neyit, 7 Fifth Harrison Avenue, Harrison, N. J.

[illegible] How to get them. Six [illegible] Book [illegible] Sent [illegible] Victor J. Evans & Co., [illegible] Washington, D. C.

[illegible] Advertising should not be without the [illegible] Write today for the [illegible] Advertising Data Folder, which explains [illegible] of ads to use. Tells [illegible] to pick [illegible] Address your inquiry to Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

For Men and Women

[illegible] Work home or travel. Experience unnecessary. Particulars free. Write, [illegible] 290-P Broadway, N. Y.

Formulas

[illegible] With Your Own Products. Make them yourself. Formulas, Processes, Trade Secrets. 10 [illegible] Catalog, circulars free. Chemco, Washington, D.

[illegible] Formulas. [illegible] Not Expected. For Making Several Selling Specialties. All [illegible] Play Hair [illegible] Vanishing [illegible] Cleansing [illegible] Literature before buying [illegible] Chemical Products, Miller Manufacturers Chemist, Tampa, Florida.

[illegible] Moneymakers and Big Illustrated Catalog 25c. Ideal Book Shop, St. Paul, Minn.

[illegible] Money Formulas. 50c a [illegible] $1.00. Neil Pharmacal Co., 805 N. 8th, Allentown, Pa.

For Sale

[illegible] Poultry. Grades all kinds. Crops, Grain Seeds, Rice. W. B. Freeman, Peebles, O., Box 148.

For the Home

HOT water on tap. $6. Make your own Automatic. Write John Kirkeby, San Luis Obispo, Calif.

GRANDFATHER clock works, $5.00. Build your own case. Instructions free. Make good profits selling your friends. Clock works with chimes for old or new cases. Write for full particulars. Clock Co., Nescopeck, Penn.

Help Wanted

WANTED: Live foreman or mechanic or clerk in every factory in the United States to act as subscription representative for the most popular magazine in the world. Address Manager of Representatives, Popular Science Monthly, 250 Fourth Ave., New York.

OBTAIN Employment ... positions you want quickly anywhere ... Ware Clay Wis. ... person was offered 70 Jobs ... complete Methods, 50 cents. Money promptly refunded if wanted. New Idea Service, Box 30-4, Station ... New York.

MEN. Experience unnecessary; travel; make secret investigations; reports; salaries; expenses. Write American Foreign Detective Agency, 302, St. Louis, Mo.

BE A ... Positions ... Women. Good pay. See the world ... Experience unnecessary. Send self-addressed envelope for list. Box 122-X, Mount Vernon, N. Y.

Help Wanted

IMMENSE profits making French plate mirrors, patented process easily learned. Plans free. Wear, Excelsior Springs, Mo.

MEN. Big pay working romantic South America. Fare, expenses paid. South American Service Bureau, 14,600 Alma, Detroit, Mich.

Help Wanted Instruction

DETECTIVES Earn Big Money. Excellent opportunity. Travel. Fascinating work. Experience unnecessary. Write, George Wagner, 2190-P Broadway, N. Y.

FIREMEN, Brakemen, Baggagemen (white or colored), sleeping car, train porters (colored), $150–$250 monthly. Experience unnecessary. 838 Railway Bureau, East St. Louis, Ill.

... A secret service man! Represent our System in your town. Experience unnecessary. Particulars free. Write Confidential Secret Service System, Box 41P, Waukegan, Ill.

$1,900 TO $2,700 YEAR. Steady work. U. S. Government Life Positions. Men, women, 18 to 50. Short hours. Pleasant duties. Common education usually sufficient. Experience unnecessary. Sample coaching, list positions and full particulars Free. Write immediately. Franklin Institute, Dept. D28, Rochester, N. Y.

IMPORTANT to advertisers! Are you decking profit from your advertising? Write today for a copy of the "Quick Action Advertising Rate Folder" showing How You Can Use Popular Science Monthly Profitably. Address our inquiry to Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

Incorporations

DELAWARE Incorporation, Charters. Fees small, forms. Chas. G. Guyer, 901 Market Street, Wilmington, Delaware.

Insects Wanted

WHY Not spend Spring, Summer, Fall gathering butterflies, insects? ... hundreds of kinds for collectors. Some worth $1 to $7. Simple outdoor work with my instructions, pictures, price list. Send 10c for illust. ... Prospectus. Sinclair, Dealer in Insects, Dept. 7, Box 1424, San Diego, Calif.

Inventions Wanted

INVENTIONS commercialized. Patented or unpatented. Write Adam Fisher Mfg. Co., 183 Enright, St. Louis, Mo.

Labels

LABELS designed and printed. Eaton, 382 W. 168th Street, New York.

Laboratory and Chemical Services

YOUR chemical problems solved and working formula or process furnished for $5.00. Write me. W. Stedman Richards, Industrial Chemist, Box 2402, Boston, Mass.

Lathes

SPEED Lathe $10.50 complete. 7 inch swing, 3 speed cone. Jefferson Mfg. Co., Fairfield, Iowa.

Letter Specialists

WRITE your own sales letters. "Making of Compelling Sale and Shows ... how." Now 25c. Coyle-Bearboro Limited, Reading, Pennsylvania.

Miscellaneous

FORMS to cast Lead Soldiers, Indians, Marines, Trappers, Animals, 151 kinds. Send 10c for illustrated catalogue. Henry C. Schiercke, 1034 72nd St., Brooklyn, N. Y.

MR. ADVERTISER: Ask today for a copy of the "Quick Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Address our inquiry to Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Avenue, New York.

No Tire Compares With DICKINSON

Our Salesmen Agents are "Cleaning Up"

-the Chance of a Lifetime!

Selling the tire that went at the rate of 230 miles per hour in the recent Florida races.

Our Salesmen-AGENTS are "cleaning up" on Dickinson Cord Tires, for they solve the biggest replacement-cost of every car owner. Unbelievable as it may seem, no other tire begins to compare with this, "The World's Perfect Tire"—*for Strength—for Speed—for Service.*

No wonder that every car owner is a willing buyer. Sales are made quick and profits are large. You don't have to be an extraordinary Salesman to make $40 a day. Through our National Advertising you have an established business ready and waiting for you right in your own locality. This is the chance of a lifetime to get into business for yourself. Immediate big money and future income assured from repeat orders. No investment. We start you—FREE.

The Dickinson Cord Tire is a tire for the classes—those who want only the best. Costs user nothing, as saving in gas ranges from 10% to 17%. It has no competition. Absolutely new and embodies correct motor-traction principles never *before applied.*

Every Dickinson Cord Tire is made on the Dickinson Automatic Tire Building Machine, of which we are the exclusive users. From core to tread it is built with automatic precision. There are no "slip-ups," no hand mistakes, and no guesswork flaws. Every Tire Perfect and a Racing Tire. "Stone bruise" is impossible. "Blowouts" are back numbers. 100% pure "live" rubber, cable-cord construction, precise alignment and scientific accuracy make it "The World's Perfect Tire" for *Longest Life—Greatest Comfort and Strictest Economy.* Guaranteed for one year against all road-hazards regardless of mileage.

Write today for Information about Exclusive Representation in Territory still open. Dept. 16.

Hydro-United Tire Corporation

J. G. FEIST, President

Pottstown, Pa. Chicago, Ill.

Address Nearest Branch

DICKINSON

"The World's Perfect Tire"

FREE

This case.
$40 a day
PROFIT . . .

This case makes the sales, sets you up in a lifetime business and makes you independent. Show the quality of a Dickinson Cord Tire and the product sells itself. Sales easy. Satisfaction brings automatic re-orders. First Applicants receive preference for Exclusive Territory. No Investment. Write Now. Dept. 16.

Name..

Address..

Town.......................... State..................

Models and Model Supplies

[illegible]

Motorcycles

[illegible] payment plan. Motorcycle parts, supplies [illegible] free. Floyd Clymer, "Largest Motorcycle Dealer in the West," Denver, Colo.

Moving Picture Business

[illegible]

Music and Musical Instruments

[illegible]

Patents

[illegible]

Patent Attorneys

[illegible]

PATENTS procured at reasonable terms with time to pay. [illegible] Washington, D. C.

Patent Attorneys

[illegible]

Patents for Sale

[illegible]

Photographic Instructions

[illegible]

THERE'S good money in your camera. [illegible]

Photoplays Wanted

[illegible]

Post Card Views

[illegible]

Printing and Engraving

[illegible]

Rabbits

[illegible]

Radio

[illegible]

Salesmen and Agents Wanted

[illegible]

Salesmen and Agents Wanted

[illegible]

AGENTS: Brush and Broom Catalog with Sample Case Assortment of 50 different kinds of Brushes [illegible]

[illegible]

IMPORTANT to advertisers! Are you deriving profit from your advertising? Write today for a copy of the [illegible] showing How You [illegible] on Popular Science Monthly Profitably." Address your inquiry to: Manager, Classified Advertising, Popular Science Monthly, 250 Fourth Ave., New York.

Salesmen and Agents Wanted

NEW discovery. Whirlwind seller, exclusive territory, big profits, free sample. American Co., 1280 California St., San Francisco.

DON'T sell for others. Employ agents yourself. Make your own products. Toilet Articles, Household Specialties, etc. 500% profit. Valuable booklet free. National Scientific Laboratories, 1970W Broad, Richmond, Va.

AGENTS: A Golden Opportunity. New interchangeable automobile monograms are the latest accessory. Only thing of its kind in the world. Silvered, never rust. Attach in ten minutes. No competition. Send $1 for any three initials. Write for exclusive territory. Service Sales Co., Box [illegible], New Haven, Conn.

AGENTS: Earn [illegible] daily. Taking orders for [illegible] household necessities. [illegible], Inc., [illegible]

[illegible] Amazing new product. No freezing. Made at home in 2 minutes. [illegible] with money making plan, etc. [illegible] St. Paul, Minn.

[illegible] for all or part time. [illegible] business house needs envelopes in different sizes, which [illegible] large quantities. [illegible] complete. The samples [illegible] and paid promptly. [illegible] would like our offer. American Envelope Co. [illegible]

[illegible] Salesmen [illegible] to auto mechanics [illegible] line of [illegible] drivers [illegible] first letter. [illegible] New Wilmington, Pa. [illegible]

[illegible] Lucky Pocket Pieces. [illegible] Easy to sell. Write today. Particulars Free. M. W. Smith, [illegible]

AGENTS: Engraved name plates, signs, numbers, easily sold, profit large. Brall Bros. [illegible] Building, Boston [illegible], Mass.

[illegible] selling new changeable signs. Every merchant [illegible]. Big profits. [illegible] Letter Sign Company, Department F, Redlands, California.

[illegible] Immense profits. [illegible], Box 382, Madison Square Station, New York.

400% PROFIT. Enormous Demand. Washes Clothes without Rubbing or Boiling. Sample Free. [illegible] Mfg. Co., [illegible], Wis.

AGENTS: Another [illegible] patented gas range safety device, [illegible] on the market. [illegible] twenty million prospects, sells on sight. [illegible] profit. Holland & [illegible] Flint, Mich.

AGENTS: [illegible] thousand mile [illegible] Louisiana.

AGENTS wanted everywhere to sell marvelous [illegible] Park Place, New York City.

AGENTS wanted [illegible] chemical cloth [illegible] magic [illegible] Dept. 52, [illegible]

GET This [illegible] necessity. [illegible] profit. Replaces [illegible] gasoline. Guaranteed. Taylor Products Mfg. Co., [illegible], Ohio.

MAKE Money. Spare Time. Men, Women, Boys, Girls. [illegible] Absolutely something different. No Selling. No canvassing. Free Particulars. Federal, [illegible], New York.

AGENTS: Success [illegible] Make [illegible] world's biggest selling Specialties. Investment small. Profits great. [illegible] selling them. Write today for valuable literature for making [illegible] Automobile [illegible] Polish [illegible] Cleaner [illegible] Money Makers. [illegible] Tampa, Florida.

SALESMEN: [illegible] Salary and commission selling [illegible] retailers. [illegible] permanent income [illegible] Rapids, Iowa, Box 839.

[illegible] A wonderful help to the housekeeper every day. Removes all [illegible] and dishes [illegible] danger of [illegible] the handle. Write for terms to agents. [illegible] Mfg. Co., Van Wert, Ohio.

GOLD [illegible] window letters and script signs. No experience, 500% profit. Samples free. [illegible] Consolidated, 69-X, West Van Buren, Chicago.

PROFIT $1,[illegible] was Chas. [illegible] for [illegible] months selling [illegible] the new [illegible] all metal [illegible] Write for territory. Fill in coupon. No obligations to you. [illegible] Mfg. Co., [illegible] Mitchell, S. Dak.

Name

Address

Town State

Ship Models

SHIP Model plans for $1. Everything for the ship model builder. Send for interesting 32-page catalog of [illegible] Milwaukee, Wisconsin.

Song Writers

SONG Writers, substantial advance royalties are paid on publishable work. [illegible] original ideas for songs may submit poems for examination and free advice. Walter Newcomer, 1674 Broadway, New York.

SONG WRITERS submit poems, professional music composing services. Bronson, Dept. 190, 1654 Broadway, New York.

SONG Poem Writers [illegible] proposition. Hibbeler, D-[illegible], 2104 N. Keystone Ave., Chicago.

SONG Poem Writers. Address, Monarch, 236 W. 55th Dept. 136, New York.

Amazing Liquid Discovery

Restores Auto Finish And Color *Like Magic!*

Goodbye, Shabby-Looking Auto Bodies! NAVON Brings Back The Original Beauty of Your Car in 60 Short Minutes. Easy As A. B. C.! Color Returns Like Magic. And Every Square Inch Glistens With a Mirror-Like Lustre That Can't Come Off! Test It Free of Risk!

GENEROUS NO-RISK TRIAL OFFER!

IMAGINE being able to restore your old car to original showroom lustre in less than an hour! Imagine being able to bring back all the beauty of its original color by a few sweeps of the hand across its surface. No wonder experts say that NAVON is the most surprising auto discovery in the past ten years!

NAVON has often been called "liquid magic" because of the speed with which it draws forth original color and makes dull surfaces gleam like burnished glass. It is not a polish—nor a wax—nor a paint—nor a cleaner! You just put it on the car right out of the can, guiding its flow with a pad of cheese cloth. No fussing with brushes or tiresome rubbing. It's more like pleasure than work, especially when you see your car regaining its original rich beauty and gloss right before your very eyes!

SAFE—DURABLE—*SURE!*

Results with NAVON are easy to secure. You can do it right in your own garage without the slightest difficulty. It's almost as easy as washing—dries smooth as glass without streaks. Even a 14 year old boy who follows the printed directions can achieve a flawless finish with NAVON!

And not only that, NAVON contains no acids, alcohol, benzol or any other injurious substance. Won't hurt metal, leather or wood. Acts both as a protective and preservative. Not affected by zero cold, freezing snowstorms, burning sun or driving rain. Can't check, crack or peel. And retains its radiant gloss for months and months!

TEST IT FREE OF RISK!

Right now—to gain new friends for NAVON—we are making a special trial offer to auto owners. This generous proposition gives you a chance to test this marvelous discovery and see for yourself just exactly what wonders it can perform. It doesn't cost you a red cent unless it improves the looks of your car 100% to your satisfaction. So take advantage of the opportunity by getting details at once! No obligation. Simply tear out the handy coupon below and mail it today! Why not do it now.

Make $150 A WEEK OR MORE

Make big money with NAVON. Agents, demonstrators and spare time workers are pocketing surprising profits. 9 out of every 10 motorists want it on sight. [illegible] made $[illegible] in a single week! Others are making big money just showing NAVON to friends, neighbors, etc.

Be the NAVON representative in your locality and get your share of the large profits that are now waiting. We are making the most liberal proposition you can imagine.

There's a wonderful money [illegible] in operating a [illegible] from $[illegible] [illegible] cars for people in your town at $[illegible] a job [illegible] in your own garage, clearing as high as $[illegible] a day.

Send for details of our [illegible] Money Making plans [illegible] with a NAVON [illegible] that will amaze you. [illegible] bottom line of coupon and mail it today!

Mail This Valuable Coupon NOW!

NAVON

INSTANT REFINISH FOR ALL SURFACES

Flows On—Stays On—Easy to Apply

CONSOLIDATED SPECIALTIES CORPORATION

Dept. C-43 21 West Elm Street

CHICAGO, ILLINOIS

Consolidated Specialties Corp., Dept. C-43,
21 W. Elm St., Chicago, Ill.

Without obligation, send me complete illustrated description of NAVON together with your special No-Risk Trial Offer.

Name

Address

Town State

( ) Check here if interested in NAVON Money-Making plans

Amazing Spray Gun Paints By Air!

No Brush! New, Easy—Quick Way

NOW anyone can own and operate a spray outfit and apply lacquers, finishing lacquers, varnishes, enamels, paints, etc. The KB SPRAY [illegible] makes painting easy, gets into the most intricate places where it would be impossible with a brush. A wonderfully smooth, glass-like finish is applied with this New Hand Operated KB SPRAY [illegible] Furniture, Wicker Ware, Screens, etc.—in fact on [illegible] in and around the house. Women are delighted with it. Makes painting a pleasure. THROW AWAY THE OLD BRUSH.

Earn Up to $100 a Week Doing All Kinds of Paint Jobs

On account of the unusual demand for this wonderful KB Hand Operated SPRAY [illegible] opens big money-making possibilities in every locality; everyone is interested in this marvelous outfit when they see the excellent work it does. A great many homes have been brightened with this amazing outfit and thousands of homes are anxious to get it. Be the first in your locality.

Special Offer
Complete Outfit Only
$9.75

The Ideal Home Painting Outfit

Agents Wanted

Write for Free Folder

KOCH BROS. MFG. CO., 5555 Lawrence Ave., Dept. 15 CHICAGO

What Chance Have You Against This Man?

This June, thousands of men will be graduated from the colleges of the United States.

Young ambitious—retired by four years of study—they will go out into the world to compete with you for advancement, and more money.

There is only one way you can hope to keep pace with these men and that is through some sort of training that will make you master of your job and the job ahead.

For thirty-seven years, the International Correspondence Schools have been helping the men who must earn their day in business or in industry yet in whose breast burns an ambition to know more about the work in which they are to attain the advancement that knowing more is bound to bring.

Nearly four million dollars have been spent in preparing the textbooks of the I. C. S. and they are as well regarded in educational circles that they are used by hundreds of resident schools. Princeton, Lehigh, Cornell, Harvard, Columbia, Syracuse, Yale and more than one hundred other universities, colleges and institutes of technology.

Mail the Coupon for Free Booklet

INTERNATIONAL CORRESPONDENCE SCHOOLS
Box 7878 C, Scranton, Penna.

Without cost or obligation, please send me a copy of your booklet, "Who Wins and Why," and full particulars about the subject before which I have marked X in the list below.

BUSINESS TRAINING COURSES

- Business Management
- Industrial Management
- Personnel Management
- Traffic Management
- Accountancy and C. P. A. Coaching
- Cost Accounting
- Bookkeeping
- Secretarial Work
- Spanish
- French
- Salesmanship
- Advertising
- Better Letters
- Show Card and Sign Lettering
- Stenography and Typing
- Civil Service
- Railway Mail Clerk
- Common School Subjects
- High School Subjects
- Illustrating
- Cartooning

TECHNICAL AND INDUSTRIAL COURSES

- Electrical Engineering
- Electric Lighting
- Mechanical Engineer
- Mechanical Draftsman
- Machine Shop Practice
- Railroad Positions
- Gas Engine Operating
- Civil Engineer
- Surveying and Mapping
- Metallurgy
- Mine Foreman
- Fire Bosses
- Steam Engineering
- Steam Electric Engineer
- Plumbing
- Steam Fitting
- Heating
- Ventilation
- Sheet Metal Worker
- Textile Overseer or Supt.
- Cotton Manufacturing
- Woolen Manufacturing
- Loom Fixing
- Textile Designing
- Navigation
- Agriculture
- Fruit Growing
- Poultry Farming
- Radio
- Marine Engineer
- Architect
- Architectural Draftsman
- Building Contractor
- Concrete Construction
- Structural Engineer
- Chemistry
- Pharmacy
- Coal Mining
- Mine Foreman
- Fire Bosses
- Navigation
- Agriculture
- Fruit Growing
- Poultry Farming
- Radio

Name

Street Address

City State

Occupation

If you reside in Canada you should send this coupon to the International Correspondence Schools Canadian, Limited, Montreal, Canada

---

$30 Every Saturday

Making Amazing Demonstration

I will pay checks for earnings every Saturday to men I appoint to every section. Work full or spare time making amazing demonstration that will make prospects thousands of dollars.

IN ONE MINUTE

Two of these demonstrations during a day will pay you $150 a week. No experience necessary—number just left.

Demonstrator Furnished

We will furnish outfit for sensational demonstration. No investment for stock or deliveries or collections. Every one a prospect. Make in homes, stores, garages, schools, offices and on farmers, etc. Many of our men now making $300 to $600 a month. Write at once to

FYR-FYTER COMPANY
32-F Fyr-Fyter Bldg., Dayton, Ohio

Stamps and Coins

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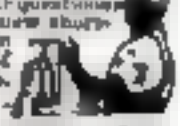

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POPULAR SCIENCE MONTHLY
250 Fourth Avenue New York

Airmen Again Fight Arctic

(Continued from page 84)

existence of what he called "Crocker Land," a territory not seen by subsequent explorers and hence doubted by them.

Captain Wilkins expected that his monoplane would have several laps on General Nobile before the Italian could maneuver his dirigible into favorable position. The plane is a Lockheed Special, capable of a 5,000-mile nonstop flight.

It carried a short-wave radio transmitter, and the most modern of avigation instruments. Wilkins' pilot was to be Lieutenant Ben Eielson, Alaska pioneer air mail flyer. He was with Wilkins in the 1926 flights into the Arctic, and has flown his mail plane on the 600-mile circuit between Fairbanks and McGrath, Alaska, on regular two-a-day schedule. He has held the controls in temperatures as low as twenty-eight below zero.

AFTER his take-off from Point Barrow in this spectacular race, Wilkins planned a course 600 miles to the northwest. If he did not discover land en route, he was prepared to come down on the ice and take soundings. Deep soundings indicate no land within a great radius. Medium or shallow soundings tell the explorer that he has only to seek a bit further and perhaps find a "Lost Continent." Additional flights, then, were to radiate fan-like out over the ice pack, until the unknown region had been thoroughly covered.

Nobile planned to fly to the Pole, anchor his big airship there, establish a base, and send out exploring parties. Then he intended to fly on into the northwest, anchor in the air again, and repeat the explorations on foot.

An ice-breaking steamship was to be the Italian's mobile base out of Spitsbergen. The dirigible's laboratory contains the latest of scientific instruments. These include a light recorder so sensitive that it will accurately record all light intensities between starlight and direct sunlight—a giant photo-electric cell, 100 times more sensitive than the usual cell of this type, and a recording meter. Whether there is less light over the Pole than in other parts of the world, and whether the light is more uniform or subject to fluctuations, will be of interest to scientists.

Wilkins and his pilot carry rifles and camp equipment, enabling them to stay wherever they may come down.

Captain Wilkins announced his mission as fourfold:

"1. To explore as much as possible of the million square miles of unknown area to the north of Alaska.

"2. To claim for the United States any land that may be found. (Although he is a native of Australia, American money finances his expedition.)

"3. If land is found, to establish bases for exploration and the compilation of scientific data.

"4. To demonstrate the existence of a short commercial air route over the top of the world, since it is shorter to fly across the top of the globe than around it from the centers of civilization."

WITHIN the next twenty-five years it is logical to assume the Arctic will be covered with a network of airways as intricate as the steamship lines that now cover the Atlantic and Pacific. The value of meteorological and commercial flying data that the explorers may gather at the top of the world may have untold importance. Circumpolar nations can, without doubt, be interested in establishing meteorological stations in the Arctic and Antarctic, and in working out a system of observations by means of which weather conditions for the entire world may be forecast in reports sent by radio from the polar areas, weeks in advance.

Letters on Telepathy That Win Awards

IN ITS February number POPULAR SCIENCE MONTHLY published under the heading "Is Telepathy All Bunk?" the conflicting discoveries of scientists on this widely discussed subject, and invited readers to write their personal experiences. Thousands of letters came from readers in every state in the Union and many foreign countries.

The awards offered for the best three letters are announced as follows:

First, $45—Adelaide V. Fisher, Vineland, New Jersey.

Second, $15—Mrs. Helene Martin, Gainesville, Ga.

Third Prize, $5—Margaret Bailey Moore, Los Angeles, Calif.

Their letters follow:

A Sister's Call

In December of 1918 I visited my mother in Sioux City, Iowa. My younger sister had taken a position in Minneapolis. She said, "If anything happens to me, I'll call you by telepathy," which, of course, was a joke.

She sent us her address then, after her careless fashion, never wrote another word. A week, two weeks passed and we were worried. Some skeptics may say this was the cause of the following experience, but they can hardly reconcile it with the results.

One night I was suddenly awakened by hearing her call, "Mamma! Come! Addie! Mamma! Come! Come!" My mother opened my door and, with frightened eyes, said, "Addie, Stella is calling us to come, I heard her call both of us."

I flew into my clothes and caught the two o'clock tram for Minneapolis. At Stella's address the landlady said, "Well, you must be 'Addie'. She is very sick with influenza and was taken to the hospital about three o'clock this morning. She called for her mother and you constantly."

I hurried to the hospital where I found my sister in delirium. I donned cap and apron and went to work over Stella and she lived.

ADELAIDE V. FISHER.

Caught in the Storm

I believe I received a telepathic message from Oklahoma a few years ago. My daughter was teaching out there. She had written me that she was going out camping Friday night.

I awoke Saturday night. An insistent something kept coming to me.

I finally woke my husband. He only laughed, saying, "Go back to sleep and quit thinking such things."

Three days later I received a letter from her saying a terrific storm had come up Friday afternoon. All the streams were swollen so they could not cross them. So the party was stranded for two nights and part of three days without much food, little clothes. She had really called me that night.

HELENE MARTIN

The Prospector's Message

Some years ago, my husband and myself were living in Southern California when he decided on a prospecting trip. He started for the state of Washington. He met a man who loaned him Hudson's "Law of Psychic Phenomena." He wrote me of his wish to experiment and told me to remain passive at ten P.M. on a certain evening. At the exact hour I distinctly heard the words, like the chime of silver bells afar off. My name was repeated several times and the words, "I love you, I love you, I love you."

He wrote me in a few days, telling me just the message he had sent (but it was more and longer) and the words were the exact ones I had received.

MARGARET BAILEY MOORE

Houdini of the Desert

(Continued from page 80)

equipment an ammunition belt, four tins of condensed rations, knife, sewing kit, light blanket, and trench shovel. From the bottom of his duffel bag he extracted a flask of whiskey. Twice he rummaged among the water containers at the back of the tent. But all were empty.

"Wait until I get back. What I won't do to those black dogs!" he muttered, then added, "If I do get back."

A shadow fell athwart the tent's door. "Thought of anything to do yet?" asked Vanderpool.

"Long ago," said Thompson grimly. "We've got to get out of here and get fast. I figure we have about two quarts of water between us. On that we've got to walk to the next water hole."

"But I can't walk."

"You've got to. I am going to strap your ankle. I'll fix you up some sort of crutch. Of course I'll carry gun and gear. Give you a hand besides."

"But won't they come for us if we wait here?"

A SLIGHT sound like a smothered choking cough came from the *doum* palm where squatted the *Ghoundo* victim. Almost instantly the two men heard the fluttering of great wings, and a wheezy croak.

"Dead, and the vultures began to come," said Thompson tersely.

"And you're going to leave him in camp?"

"Going to leave the whole shooting match, camp and him and the birds, just as soon as we can. White men don't often get *Ghoundo*. But I'm taking no chances with the vile thing. Come on."

One gun, one knife, one camp axe, a little food, an aluminum bottle of water, and two men—a man and a half would be more accurate—a pitiful party moving with microscopic slowness across a dreary waste of sand-baked clay, burnt grass and thorn-bush scrub.

They had set out just before sunset. Thompson explained to his miserable companion that they must not travel in the heat of the day. With so little water available, and so many miles ahead to the next hole, they must not waste their bodies' precious liquid by struggling forward when the sun was at its height.

After almost three painful miles they camped. This process consisted of building a small fence or shelter on the shadowy dusk. Not shelter against the heavens' myriad stars overhead lulled the proximity of rain that would have meant so much. But against the prowling carnivores of the night, the lion and the leopard, both of which infested these plains even in the dreadful dry season.

"There's one of the rats now," said Thompson as a strident howl-yapping—"ta ra-ra-ra-ra"—rose from a narrow bush-filled donga not a hundred yards away.

"You think it's safe to sleep?" inquired Vanderpool, puffing over the bandages that encased his game leg.

"Decide for yourself," said Thompson curtly. "I know I'm going to."

AS THE white hunter worked, the basket became more hopeful. He saw a three-sided thick thorny wall grow as Thompson deftly cut the heavily armored bushes, native-fashion, and dragged them together. Even Vanderpool did not appreciate the skill it took to handle the spiked branches without tearing one's flesh to ribbons. In half an hour Thompson, with his skin intact, announced the job complete.

Now it was dark. A camp fire built of *doum* palm branches and other debris raked from the dry bed of a near-by creek reflected the glowing eyes of night prowlers already closing in upon the men. The fire was (Continued on page 140)

Houdini of the Desert

(Continued from page 139)

placed on the third and open side of the boma, completing the defenses behind which both could sleep in reasonable safety.

Vanderpool was game. He knew the last water hole had been but three short marches behind on the way out. Surely they could reach it in double that even on foot.

But he had not counted on the blistering heat, on the torment of the sun-baked bubbles underfoot, the constant strain of being on the outlook against lions, or on traveling on far less water than the body craved.

Already it was June. The rainy season was over. The damp sand in which Thompson dug could not be made to yield a single drop of water.

Vanderpool had camped in America. To him water meant a sparkling spring. On the way out from Nairobi he would not believe Marvin Thompson when the latter took him to a muddy, scummy pond [illegible] as the goal of two days' marching. That was when they had their still and could boil out some clear liquid from the soupy mess in which a thousand head of game had recently trampled.

TRAGEDY now came upon them. By superhuman effort they reached the water hole. But ten days had passed since their last visit. Also had passed their own deserters, camels and donkeys. And in addition there had come and gone from the bone countless herds of African game, all with hot bodies and parched bowels.

As a result of all this, coupled with the deadly sun, the water hole had dried up. Only mudholes remained. Edges of the mudholes were curled up grotesquely by the roasting heat.

Vanderpool was very weak. When he saw there was no water in the hole he sat down and wept without shame or reservation. Marvin Thompson's face was drawn with suffering. But there was no sign of weakness in it.

"Buck up," he croaked through a throat dry as cardboard. "We're not lost yet."

"Might as well be," blubbered Vanderpool, "as to suffer like this."

"No. There's Kalua hole two days further on."

Vanderpool mouthed his swollen tongue before he could retort. "Yes, two days by mule. We can't even stand up for two days longer."

At this moment Thompson, who had been sitting disconsolately by his miserable friend, suddenly scrambled to his feet. He swayed slightly as he stood up, but he gripped his rifle and half brought it to his shoulder. Vanderpool looked up with little interest. He had already shot two lions, on the way. No longer did their presence faze him.

"The Arm again," cried Thompson.

ACROSS the little clearing in which lay the dry pool came a stamping and noisy breathing. An elephant strode out of the bush. Another and another.

"Elephants!" cackled Vanderpool in half delirious laughter. "What we came after! Now I'll get one. What?"

At the noise of the men's voices the elephants barked cautiously into the bush from which they had emerged. Thompson stood alert, watching to see if they would appear again, his rifle swung ready in the crotch of his arm. Well he knew that if the elephants took a notion to investigate them there was no possible way to escape. Vanderpool was far too weak to run. There were no trees. Probably neither could shoot straight in the present condition of their nerves.

The elephants did not reappear. For half an hour Thompson waited, hope growing within him.

"Maybe they've got [illegible]

(Continued on page 141)

Houdini of the Desert

(Continued from page 140)

a sand hole over there," he said. "You know they scrape under a river bed when the water holes dry up and sometimes bring in a spring. Wait, I'll go and see."

Cautiously he walked over to the spot where the elephants had disappeared. Entering the brush he followed their trail made plain by broken branches and heavy footprints in the sandy dust. Then the ground became hard-baked again, the bush widened and the trail faded out. For half an hour he hunted cautiously for spore or footprint to help him follow on to the water he knew the herd must have near by. But without success.

He grew afraid for Vanderpool. The man was in no shape to be left alone on an open African plain. He turned back toward the dry hole. As he came out upon its clearing a startling sight met his eyes.

THERE on the ground where he had left him sat Vanderpool. But he had turned with his back to the water hole. Facing him, and not twenty feet away, was a monstrous bull elephant, gorgeous white tusks curving down and out from his jaw, a good ten feet from root to tip. The elephant's trunk was outstretched and snuffing loudly. His ears spread vertically from his shoulders. His feet were doing a curious mincing dance, and his gigantic body swayed from side to side in fury.

"Come on! Come on!" screamed Vanderpool in the madness of his thirst. He then broke into a volley of profanity mixed with maniacal laughter.

Thompson's first impulse was to run to the assistance of his friend. But he knew by experience that such a move might only bring on the charge that would almost instantly be fatal to the sick man.

"Shoot low! Aim for his eye!" he called as loudly as he dared.

"You big black bully, you!" screeched Vanderpool, rocking with insane mirth. "One more step and I'll kill you!"

"If he only could," was the anguished thought that crossed Thompson's mind as he realized how small the chance was that the fevered and untrained eye of Vanderpool could direct his bullet to a fatal spot in the beast's mountainous carcass.

SUDDENLY Thompson himself seemed to go mad. He stiffened as if the elephant had begun to charge him. He took a faltering step forward, then broke into a run directly for Vanderpool, at the very instant the latter raised his rifle to his shoulder to shoot.

"No!" shouted Thompson. "No, don't shoot him. *I know him!*"

To an onlooker the words would have seemed those of a hopeless lunatic. For a man to claim acquaintanceship with a wild African elephant, especially one that threatened the life of a helpless man dying of thirst, was beyond the limits of wildest imagination.

But Vanderpool was anything but an onlooker. Also he was hardly himself. Thompson reached him before he fired and jerked the gun out of his hands.

At this second failure to be allowed to shoot an elephant after all his sufferings and hardships, Vanderpool behaved exactly as a child would have done under similar circumstances enacted in the nursery. He rolled over on his face, dug his fingers into the dry soil, and bawled as lustily as his weakened condition would allow.

"Oh, you always spoil it! Always!" he sobbed. "What's the use?"

Thompson stood quietly, his eyes fixed on the bull.

"Houdini," he said, his voice shaking slightly in his effort at self-control. "Houdini, don't you know me? (Continued on page 142)

Houdini of the Desert

Continued from page 141

Don't you remember what I used to do for you?'

At the sound of the man's voice the big elephant's little beady eyes blinked incredulously. Again Thompson spoke, this time pleadingly. The elephant's ears flattened slowly against his massive head.

In deliberate steps Thompson walked around the animal until he stood to windward in order that it might get full value of his scent. Houdini grunted loudly, swaying his head to and fro in an absurd negative sort of motion and slowly backed toward the bush, into which a moment later he seemed to melt.

Thompson turned to Vanderpool. "Quick, get up!" he commanded.

"Why?" asked Vanderpool, rolling to a sitting posture and controlling himself somewhat.

"I think we're saved."

"YOU mean you saved the elephant." The banker seemed about to break down again.

"I know him. Did you notice that the tip of his left tusk was broken sharper?"

Vanderpool nodded foolishly. "Yes."

"Well, he's an old fellow that used to hang around my camp up at Tumi Lake. Came there for three years straight. I used to dig up our sweet potatoes until I began planting some for his own use. He got to know which potatoes were his and let ours alone. Absolutely the only African elephant I ever heard of that showed any signs of becoming tame."

Suddenly and as if by magic, the big bull stood before the two men again. He had emerged from the brush so silently that neither had heard him come.

"There," cried Thompson. "That's why we called him Houdini. Watch him."

A moment later the elephant moved leisurely back into the brush. Not a twig cracked under his huge feet, not a branch broke against his rough back. His movements were as silent as if he were only a monstrous black shadow melting in and out of the thorn trees through which not even a man could pass unscathed.

"No one but Houdini could do it!" exulted Thompson.

Again the elephant appeared, as mysteriously as before. He put his trunk out when Thompson spoke to him. But he came no nearer. Deliberately he turned around and began to nibble at some of the more tender shoots on the ends of the hard dry branches. Presently and without looking around, he sidestepped into the brush again.

"BUT you said we were saved," broke out Vanderpool, his weakness and fever coming back again after the momentary stimulant of the scene.

"A hunch," said Thompson a little ruefully. "Let's see if I'm right. Come on, I'll help you."

Together they followed the heavy trail left by the miraculously friendly Houdini. Every now and then they would come upon the big fellow standing silently just ahead, as if waiting for them to catch up. At such moments Thompson maintained silence while he spoke aloud in friendly fashion to the elephant.

But his heart sank when he saw that Houdini was leading them along an upgrade in the plains. No water could be on a rise. Their one chance to find the life-giving liquid lay in the dry river beds at the lowest point of the land.

Thompson knew he couldn't go on much longer. Vanderpool was fretting and subtly raving again in his delirium that had returned. Nearly the full weight of the man was on his shoulders. He might struggle on for a few hundred yards farther. Certainly not more.

They had now reached the top of the rise. Once more Houdini had melted away into the thorn bush. Dropping with exhaustion, Thompson laid Vanderpool gently upon the ground and walked forward a few steps toward an opening in the brush through which it appeared he might gain a view of the plain. The level of the table-land was sixty feet or so below the vantage point to which Houdini had led them.

Carefully avoiding the sharp prickers, Thompson peered out. His bloodshot eyes skirted the ugly desert land for halfway around the horizon. Suddenly they stopped, widened. He gave a cry, turned and rushed back to Vanderpool.

Seizing the man's shoulders he lifted his head into his lap and poured the last remaining water from his canteen down his throat.

"Pull yourself together, man," he urged frantically. "I've found our gang! They're right below us. Here, take my arm."

That night Boruty, native headman, had many alibis. He explained that the Ndolo Mountain men had gone into a panic when the case of *ghanda* fever had shown up. He could not restrain them. Now they were gone—gone forever he hoped. His own people, the natives Thompson trusted, were about to start back for the white men. He went on to say that there was plenty of water half a mile ahead—a spring hole his brother had found.

"Do not beat me, master," he entreated.

Vanderpool came up at this moment. He was not himself yet. But he had an urgent job to do. He explained to Thompson what this job was, but the latter was too busy berating his black men to care or to understand.

WHEREUPON, an hour later, when Vanderpool was still missing, a search party was sent out to find him.

"White Chief left on his mule with bucket of water," testified one of the natives.

"That's a lie," commented Thompson.

But the native was right. Half an hour later Marvin Thompson himself located Vanderpool. The banker was up a tree, an empty water bucket on the ground below him. Standing guard under the tree was Houdini. Combined shoutings of six men drove the elephant away.

"Thought I'd take the old fellow a drink," explained Vanderpool sheepishly, "but he wouldn't stand for it."

Which ends the yarn except for the fact that Vanderpool left Africa three weeks later without an elephant head to prove his valor. "After meeting Houdini," he later explained at his club, "I couldn't quite bring myself to kill an elephant."

Tesla, Wizard, Designs Air Flivver

DR. NIKOLA TESLA, New York City electrical wizard and pioneer radio experimenter, has just taken out patents on a vertical-rising helicopter of his own design. He is certain it will fly, he says, although no model has been built.

The machine, a combined airplane-helicopter, would be the ideal air flivver, Dr. Tesla says. It has a wing spread of eight feet, and the same width and height. Two persons could fly in the craft, which is to weigh 500 pounds. A hybrid motor, a sort of turbine that embodies the principles of the present internal-combustion aero engine, would lift the craft vertically until it was clear of the ground, through a lifting propeller that would then tilt forward for lateral flight.

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The Movie Maker

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It does give wonderful depth to the picture, but it has some drawbacks. For one thing, we couldn't fake perspective with a double-lensed camera." Don concluded his technical lecture with a final squint through the finder and gave the order for lights, action, and camera.

The sequence was very short, but it gave a bit of twelfth-century life and comedy which Don knew would add richness and reality to the presentation of medieval England. His final touch of trickery to complete the illusion of distance was the placing of two tall, stalwart men-at-arms on each side of the foreground arch, while in line with them he had two small boys in duplicate costume, make-up, and weapons stand just before the painted back drop of a similar, though much smaller, arch.

* * *

A BIT of war-torn France behind the enemy lines. A strip of no man's land with tangled vines of barbed wire, and yawning shell holes. And around and about this carefully arranged horror and confusion, assistant directors and workmen moved, making shell holes more perilous, the whole scene more ghastly.

As the war sequence was only a shell holding the main story the battlefield sets did not need to be extensive, but Don wanted them realistic, and by making out a combination of miniature and large sets he contrived several hundred feet of thrilling war drama. And because it involved only a struggling bit of a lost battalion that had gotten too far ahead of the main line of battle, he used not more than a hundred extras for the scenes.

The big set was designed primarily for Jerry's exploits, in which he was to crawl from hole to hole over the strip of no man's land, while an occasional carefully planned explosion was set off by an electrician some distance away. The powder charge had been planted just below the surface of the field, and when the fake bombs landed on certain specific spots they were blown to pieces by the hidden explosives, amid clouds of flying dirt. The location of the several explosions had been carefully charted and were marked in such a way that the actors knew how near they dared approach. They appeared to dash over the field in wild charges, but the action and explosions were timed with extreme accuracy. To heighten the effect, several dummy "corpses" were tossed into the air, and some of the doughboys advanced near enough to the charted areas to get covered with the flying earth, a few doubling up apparently in death agony.

THERE were three big moments in the war sequence. For one Don used the entire force of extras and marched them across a field. Their objective was a small grove of trees on the other side, but before they could make it an enemy plane was to swoop low. As Don planned it, the aeroplane on the screen would show the airplane passing not more than four feet above the heads of the soldiers.

But when the cameras shot the scene on the lot they photographed merely the terrified soldiers stooping to dodge an invisible menace, their ranks thinned by machine-gun bullets as imaginary as the airplane. Several days later Don would photograph the plane in action over the Los Angeles air field. Then the two shots would be combined on his background machine, leaving a narrow strip of sky between the plane and the marching soldiers.

Another exciting bit was to depict the shelling of a French village while soldiers were passing through. For this the soldiers walked in rather irregular line of march down a strip of the field cut off from the rest of the lot by white canvas backgrounds. When the men in the front ranks had reached a designated place, Don, with stop (Continued on page 145)

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watch in hand, shouted an order. All who had reached a certain point fled on toward the camera. Those in the rear, who had not passed a second point drew back in terror while the majority, caught between the two points, flung themselves flat on the ground. And the next day, camera men, timing their exposures proportionately, photographed the shelling of a miniature village in which a large, half-wrecked church collapsed and crashed down over the roadway, burying part of the line of soldiers. When Don later combined the two shots, he was obliged to send the resulting negative to the laboratory for the painting out of a number of the extras who had not quite landed in any of the three scenes when the church topped over.

And then the services of "Buck" Lacey, the screen's greatest stunt pilot, were called upon. He lived a charmed life and would ride anything that took the air no matter how old or wobbly. He had a collection of ancient "Jennies," sold him as junk, which he patched up and used in any stunt that required wrecking a plane.

ALTHOUGH most of the airplane shots were to be taken above the field in Los Angeles, Lacey's stunt had to be performed on the lot at Cinema City. One bright morning early in December his plane arrived by truck —even he did not care to bring it very far through the air and he roared in on a motorcycle an hour later. After he had rolled the plane into position on the lot, he stood aside while a bit of footage was made of Jerry getting into the plane. The propeller was swung and the machine started down the field, stopping, however after a short distance. Jerry stepped out and Lacey a caricature of a football player, draped with leather pads, shin and nose guards, breast, arm and shoulder protectors, and a crash helmet, climbed into the cockpit and jammed three large pillows into the forward part.

His objective was a small cabin at the edge of a little grove, before which stood two tall trees, skeleton sentinels blackened and stripped almost bare of branches by shells and gunfire. Don had bought them from a contractor who supplied poles for telephone lines. After being doctored realistically by the scenic department, they had been set in concrete before the cabin, the space between their trunks being hardly more than the width of the fuselage of Lacey's plane.

AGAIN the plane started down the field, lifted, and after a short straightaway flight, returned to circle about two hundred feet overhead. Knowing there could be no retakes, Don had six cameras working on the scene. Then Lacey swooped down, apparently losing control of the plane, but in reality guiding its fall toward the cabin.

Straight between the two sentinel trees plunged the mad plane, while the cameras clicked. There was a tremendous crash as it shot squarely between, shearing its wings off clean, and diving head-on into the cabin. The tree trunks were snapped like toothpicks and the cabin crumpled under the bulletlike impact of the fuselage.

Almost before the camera men had stopped cranking and while everyone rushed toward the wreck, Lacey rolled out and grinned, tossing his helmet into the air. A shout of congratulation went up from the spectators. Feeling somewhat ashamed of his own safe rôle, Jerry clapped the reckless one on the back.

"And now the handsome hero does his death-defying stunt of fooling the dear public" announced Jerry as he minced up to the cabin and wriggled into the hole out of which Lacey had wormed himself.

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completely disappeared, the cameras were started again and a moment later he crawled painfully out of the cabin. Made up to look distressingly wounded, he dragged himself across a few feet of ground. Then he rose and walked briskly beside the camera men the rest of the distance to no man's land, where he again resumed his crawling position and collapsed, unconscious, beside a wounded comrade.

* * *

"Not more than twenty-five feet can we take in a day—some days maybe only twenty," remarked Professor Mahlbrotburg as he bent the tail of the largest dinosaur a fraction of an inch, stretched the ugly mouth a trifle wider, and shifted the tiny wires controlling the eyes.

"Then it'll take about ten days to finish this sequence," estimated Don, watching the old man adjust in a similar manner a miniature brontosaurus engaged in deadly combat with its prehistoric neighbor.

THE professor nodded, absorbed in his task. At Don's request, he had turned director, and with two assistants he had been at work for several days on the process, known as "animation," by which the models would appear ferociously alive when projected on the screen.

The animals were being photographed on a long, low table that held a miniature battleground set, scarred and torn by war. Jagged, tangled barbed wire barriers, shell holes two inches deep, stumps of uprooted pygmy trees, abandoned toy rifles, lay on the field, and over this waste and destruction another conflict now raged—the battle of the beasts.

Screwed into place around the table was a battery of motion picture cameras, electrically operated. After each tiny adjustment the professor and his assistants stood away from the table. The professor pressed a button and the shutters of the ten cameras opened simultaneously just long enough to expose one frame of film. Then another laborious fractional adjustment of the animals on the battlefield, and another exposure.

DON had been likened in the use of cameras, for "animation" is a long and tedious process, and by having the scene photographed from every possible angle he hoped to get an abundance of fine shots without the necessity for any retakes. To allow for extensive spoilage and cutting, if necessary, he had made a rough estimate of two hundred feet of film from each camera, and since there are sixteen frames in each foot of film this involved more than three thousand separate exposures, with the patient, laborious operation of changing each time, ever so slightly, the position of the dozen or more animals covering the battlefield. Although the largest animal was only two feet long, they were gigantic in relation to the miniature battlefield, and would appear even more terrifying when combined with negatives made of actual soldiers. To allow for these double exposure shots, the lenses of several of the cameras were partially masked.

Well above the range of the lenses, but within reach of the professor and his assistants, hung a framework as long as the table. From it was suspended a network of tiny pulleys, weights, and wires so fine as to be almost invisible, the ends of the wires being attached to various portions of each beast's anatomy. Even as Don watched, he saw one of the assistants start a pterodactyl, a hideous flying reptile on a slow motion flight to the opposite side of the battlefield. It would take more than thirty separate exposures to get the fantastically horrible creature across that three-foot span, but when the picture was finished and projected, Don knew that the flight would appear a vulture swoop.

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The wires were useful, also, in balancing the animals in any position as they turned and tumbled and tore at each other, ripping great gashes in one another's bodies, from which thick molasses, inserted at the proper moment and squeezed out with calculated slowness, gushed forth in the guise of blood.

* * *

At the end of the long day's work, Don stopped for a few moments in his office to check the receipted November bills against his bank balance. There was no longer any doubt about money enough to finish the picture, for Silas Rogers had sent in his final twenty-five-thousand-dollar check promptly on the first of the month.

DON snapped the rubber band on his bank book thoughtfully. He had an appointment with Rogers for the following evening and he wondered who would emerge victor. For he had decided to play another game of chess with Mabel's father and offer him a third share in his invention for fifty thousand dollars. That would leave the control in Don's hands, yet it would be a better deal, financially, for the newspaper owner than a half interest at one hundred thousand. Don hoped that the lure of a bargain would influence Silas Rogers to accept the offer, for Margaret must be assured as soon as possible that the money would be ready when she needed it.

"Don, won't you come home to dinner with us?" The object of the young director's thoughts paused in the doorway. "Father is waiting in the car."

"Thanks a lot, Margaret, but I'm getting just a sandwich and a cup of coffee at the drug store. I'm due back at the laboratory Canfield and I have a full night's session."

As Margaret entered the room and stood near his desk, Don rose to chat with her a moment. Unconsciously, he still fingered his bank book and her gaze was attracted to it. She smiled at him with quizzical understanding.

"It's something of a strain, isn't it?" she asked. "Being director, producer and financier all at once."

"Only when I think how much I owe you for—"

"Don, I've told you I won't listen to any such nonsense!" Margaret interrupted. "We're all putting everything into this picture just as you are—because it belongs to us!" She held out both hands and he gripped them heartily.

"BUT it was you and your sapphire ring that started us last summer," he insisted. "I felt like a cad, selling your ring, but I've doubled twice the amount of its sale against the picture and—"

"Foolish!" Margaret laughed up at him and tried to withdraw her hands, but he held them firmly a moment longer.

"And with my first check from the profits I'm going to buy you a ring that will—"

"Oh! I beg your pardon."

The two looked up in surprise as Judy, hurrying into the office, stopped so abruptly that she almost tripped.

"Come in, come in!" called Don, as she turned quickly to leave the room. Though his hands had automatically relinquished Margaret's at the sound of another's voice, there was constraint in the air—Judy had stared as though she had unexpectedly come upon a pair of lovers. Absurd! Anyone could tell that Margaret and he were only very good friends. Yet he couldn't clear the atmosphere by crudely announcing that, could he?

Somewhat embarrassed, he glanced from Judy, standing awkwardly in the center of the room, to Margaret beside him, and caught the latter's eyes dancing with suppressed laughter. His own twinkled a response. Margaret understood, of course. (Continued on page 148)

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Judy was a dear little dunce to be so blind, and perhaps he'd tell her so tonight—he felt reckless. He turned to her expectantly after Margaret had left the room with a murmured good night.

But Judy met his eager eyes with a pleasantly impersonal gaze.

"I just stopped in to tell you Jerry and I are going out to the ranch a little before noon tomorrow. Jerry will be at the field in time for the airplane shots in the afternoon. You won't need me there, will you?"

"Why, no, but I—"

Don's sentence trailed off unfinished, for, turning briskly on the heels of her trim smart riding boots, Judy had departed.

* * *

With somber, unseeing eyes, Judy looked out across the dry sandy fields edging the road. Here and there a green square marked a crop of alfalfa, the fourth and last of the year still unharvested. A few miles farther on Jerry's ranch was an unirrigated sandy area that gradually narrowed into a sliver of canyon between the first low ridges of the foothills.

JERRY'S ranch. And yet, because he had so generously deeded it over to protect her in emergency, she was stubbornly blocking its sale. Selfish!

Not sparing herself at all in her doleful mental monologue, Judy sat silent as I decreed beside her brother as they sped along. She had never really considered the ranch hers, but now that Don and Margaret were to be married—"*with my first check from the profits I'm going to buy you a ring!*"—she must have some place to which she could retreat while the wound was still raw and smarting. And then she'd have to find some way to support herself. She couldn't go back to the pictures—she couldn't!

"Celebrating national gloom week, eh?" Jerry nudged her shoulder and she glanced up at his smiling face. But she did not respond.

I'm not going to sell the ranch, Jerry. Her head drooped. In spite of her misery, she felt ashamed to be such a stubborn little beast. A coward, too!

ALL Jerry's coaxing and argument were in vain. And when they found the two real estate men they had promised to meet, waiting for them at the ranch, Judy still refused to give her consent. A tall real estate broker in dusty gray suit added his persuasions. His equally dusty brown suited partner pointed out advantages. All the flimsy reasons which Judy advanced for keeping the ranch were swept before her and knocked flat like paper dolls, until the only thing she could cling to was the central stubborn fact that she would not sell the ranch! And she clung to that so persistently, so unreasonably, and finally so hysterically that the brown and gray partners were obliged to play their trump card.

"Forty thousand dollars for the place!" announced the tall gray one, and he looked hard at Jerry.

Judy? There was an imploring note in Jerry's voice. Never again could he hope to have such a ridiculous offer.

But the small figure of dejection seated on the cottage steps shook its head in passionate refusal.

Jerry muttered an exclamation of disgust, then looked at his watch.

"Sorry," he told the partners, "but we're due on the flying field within an hour. Suppose you telephone me tonight at the hotel after my sister and I have had a chance to talk this thing over."

The men looked at each other warily, then the shorter one spoke.

"Sure we'll call you, but the offer ain't good after tonight."

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Your sister better hurry and make up her—"

"Then I'll expect to hear from you tonight." Jerry curtly terminated the other's mashed advice.

"Mind if we look over the place again?" asked the broker.

"Stay as long as you please." Jerry replied. "We're leaving in a moment."

They walked off in the direction of the canyon, and Jerry went around to the back of the cottage. He returned with a dipperful of water which he presented to his tear-stained, disheveled sister.

"Don't drink it," he warned her. "We'll have to get the well cleaned out—the water tastes queer. But you can sop your face with it. I don't want to take you back to town looking like a ripe tomato."

"I—I'm not going back now," she replied feebly. "I'm not needed this afternoon, so I'll just go into the cottage and take a nap. You can come for me when you're through with the air stuff, or I'll walk to the road and take the bus in."

"I'LL come back for you, of course." Jerry rumpled his sister's hair with a roughly affectionate hand. The kid did look miserable, but he had no time now to stop and dig out the cause. With a well calculated leap from the steps, he landed on the running board of his car and was soon bumping along the mile strip of ruts and holes that ran from his front door to the Los Angeles highway.

Thirty thousand dollars for the ranch! More than twice what it was worth, especially with that freight line running through it. Somehow, he couldn't believe that the real estate people wanted the ranch for an allotment—it was too far out and lacking in landscape features for that. Were they trying, under cover, to buy up a huge acreage for a new motion picture city? Rumors of that sort were always flying about.

Not twenty minutes after Jerry had disappeared in his own cloud of dust, his sister, exhausted by emotion, was drifting off to sleep in the bedroom at the rear of the cottage. But a grinding, clanking sound recalled her drowsy senses and she listened annoyed: those real estate men pumping water from the well. Would they never go and leave her in peace?

And then she heard one word that banished sleep and weariness and even sorrow for the moment—*oil*. With a quick, silent motion she was out of bed and stooping down beside the shade-drawn window.

THERE stood the dusty pair, the dipper in the hand of the taller one. And as he turned it slightly to get the sun's full rays on the scummy surface of the water, he gazed at it hungrily and talked in low, eager tones.

Judy crouched by the window until they went around to the front of the house, where they had parked their car. She heard the hum of their starter, the explosions of the engine. Then she leisurely bathed her face and hands, combed her hair, and got into her riding suit. She wanted to give the partners plenty of time to reach the Los Angeles highway before she set out on her dusty, one-mile trek. Naturally, they thought she had returned to the city with her brother, and she did not care to have them suspect otherwise. Fifteen minutes later she set out along the same road. If she were lucky enough to make the next bus, she would reach the air field before Jerry was through.

* * *

When, after his last crash, Jerry had promised his sister to "quit the game," he had referred only to stunting. Judy knew as well as he that he could never give up flying. In the studio, during the close-ups of the air scenes, Jerry had fretted and fumed constantly, his desire for a real

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airplane revived by the studio imitation in which he did his acting. It was only a part of a plane in which he sat—the cockpit and central portion of the wings—mounted on a turntable platform which could be tilted at almost any angle to indicate an airplane in flight. Beyond the camera deadline a wind machine was operated at such high speed that when Jerry, contemptuous of its force, removed his helmet, his smarting eyes filled with tears and he had to duck his head to escape the cutting blast.

But it only made him homesick for the real thing; so when Don, in planning the shots to be taken actually in the air, had decided to go up with the camera himself, Jerry had eagerly volunteered to pilot the plane.

"It gives me a pain in the neck," he had growled, "sitting like a Hollywood doll in this sawed-off studio cockpit while some stage hand unrolls cloud effects back of me! When I aviate I want to leave the ground."

* * *

WHEN I aviate I want to leave the ground. A thousand feet above the flying field that afternoon Don recalled those words of Jerry's and chuckled—chuckled in spite of their precarious, even dangerous, situation. For Jerry had certainly left the ground and had left a wheel of the plane below him, striking a bump near the end of the field, just as they had taken off more than an hour before, they had lurched sharply and then had lifted to the smooth velvet of the air. Not until one of the stunting planes, rising after them, had dangled their lost wheel before their eyes and pantomimed the accident, had they known that anything was wrong.

But time enough to think of that after the air scenes had been taken. So for an hour they had been cruising above the field, Don cranking the camera while Jerry jockeyed for positions that would give startling camera angles of the other planes. The flying itself was not unusually spectacular, for the most thrilling stunts had been worked out on the lot or in the laboratory.

One of these was a fight in the air, in which the vanquished plane spun flaming to the earth. The spectacular and apparently hazardous part of this sequence took place entirely on paper, for the professor and his artists had prepared nearly three hundred wash drawings—each drawing advancing the action an imperceptible trifle—of a plane bursting into flames as it fell. Photographed in sequence, a frame of film being exposed for each drawing, the action appeared continuous and thrilling. The scene had actually been photographed in the air to the point where the defeated plane dropped like a skyrocket, there would be the joining between the "faked" and the real shots, while a close-up of the wounded aviator, made in the studio, would be splced in between.

AND now, all the camera work done, Jerry was turning and banking a thousand feet above the field—getting ready to land, evidently. With his arm shielding his face from the backrush of air from the propeller, Don leaned over the edge of the cockpit for a view of the revolving panorama beneath.

To the west, toy battleships floated at anchor in San Pedro harbor. Green and brown and red, almost directly below him, the squares and sections of Los Angeles were an irregularly patterned chessboard, bordered in one direction by a yellow expanse of desert, in another by Hollywood, rising gradually to merge with the shadowy green of Beverly Hills. Dull brown in the distance, the uneven line of the foothills curved eastward like the broken rim of an old earthenware bowl worn smooth by age.

But the earth was not rising to meet them. Was Jerry going to cruise around for the rest of the afternoon? As

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Don settled back into the cockpit, he caught the grin that Jerry flashed at him and saw his hand go up in a reckless, gay salute. Then, its nose to the sun, the plane gathered tremendous speed and roared in an ascending spiral toward the ceiling of the sky.

As they rushed upward, Don had the sensation of staring down, not up, and instead of flying they seemed to be diving smoothly, buoyantly, into the turquoise ocean of the sky. The blood tingled in his fingertips. His heart beat double quick and gaily, while under his skin a thousand little needles pricked and quivered. In spite of the icy velocity of the gale, colder than anything he had ever experienced, he again leaned out over the edge of the cockpit. Far, far below, the earth was a flat dark mass, where people grubbed for a living. He seemed never to have belonged to it; always he had been suspended in this shining void.

And then the earth began to rise. As it drew nearer, Don felt suddenly very tired. The exhilaration of the sky had passed, leaving him numb and weary. Now for the test of Jerry's skill—or luck! Of course they would scrape through all right, Jerry always had; but Don thought of his will with a faint sense of relief. The others were protected, the picture was taken care of—just in case . . .

REMEMBERING the picture, Don's hand went out to the camera. No matter what happened, he might be able to save it and the scenes on the reel. In a moment he had loosened the handscrews that held the camera clamped tight to the edge of the cockpit. He lifted the camera out of its socket and adjusted it firmly in the curve of his left arm, tight against his chest. Then with his right hand on the safety belt ring that would release him from his seat, he glanced downward.

They were perhaps three hundred feet from the ground now, he judged. Below, two motorcycle policemen rode up and down, holding back the crowd. Don's eyes followed the scene indifferently. Everything was blurred, as in a dream. Any moment, now . . . And yet there was nothing to do but wait passively.

The plane tilted slightly toward the left, gliding lower. Don noticed a hearselike vehicle at each end of the field. Ambulances . . . white-suited internes standing ready with stretchers. It was like looking down on preparations for your own funeral. But none of it seemed real. Airplane crashes, pile-ups, and explosions happened to people in newspapers—something to read about but never to experience. Yesterday's headlines flashed through his mind: CRIPPLED PLANE CRASHES . . . GAS TANK EXPLODES . . . CHARRED AND BLACKENED BODIES . . .

Now they were down below the tree line. Now faces swirled past them, streaked together in a flying circle. Now they must be just skimming the ground . . .

THE plane rocked into a side-slip—lifted slightly. Jerry's arm swung up as if in a signal.

Obeying blindly, Don with one swift move was on the edge of the cockpit, hugging the heavy camera close. As he crouched for a jump, the plane scraped and lurched violently to the right. Rising in a somersault, the plane tossed Don like a springboard as he leaped out and forward.

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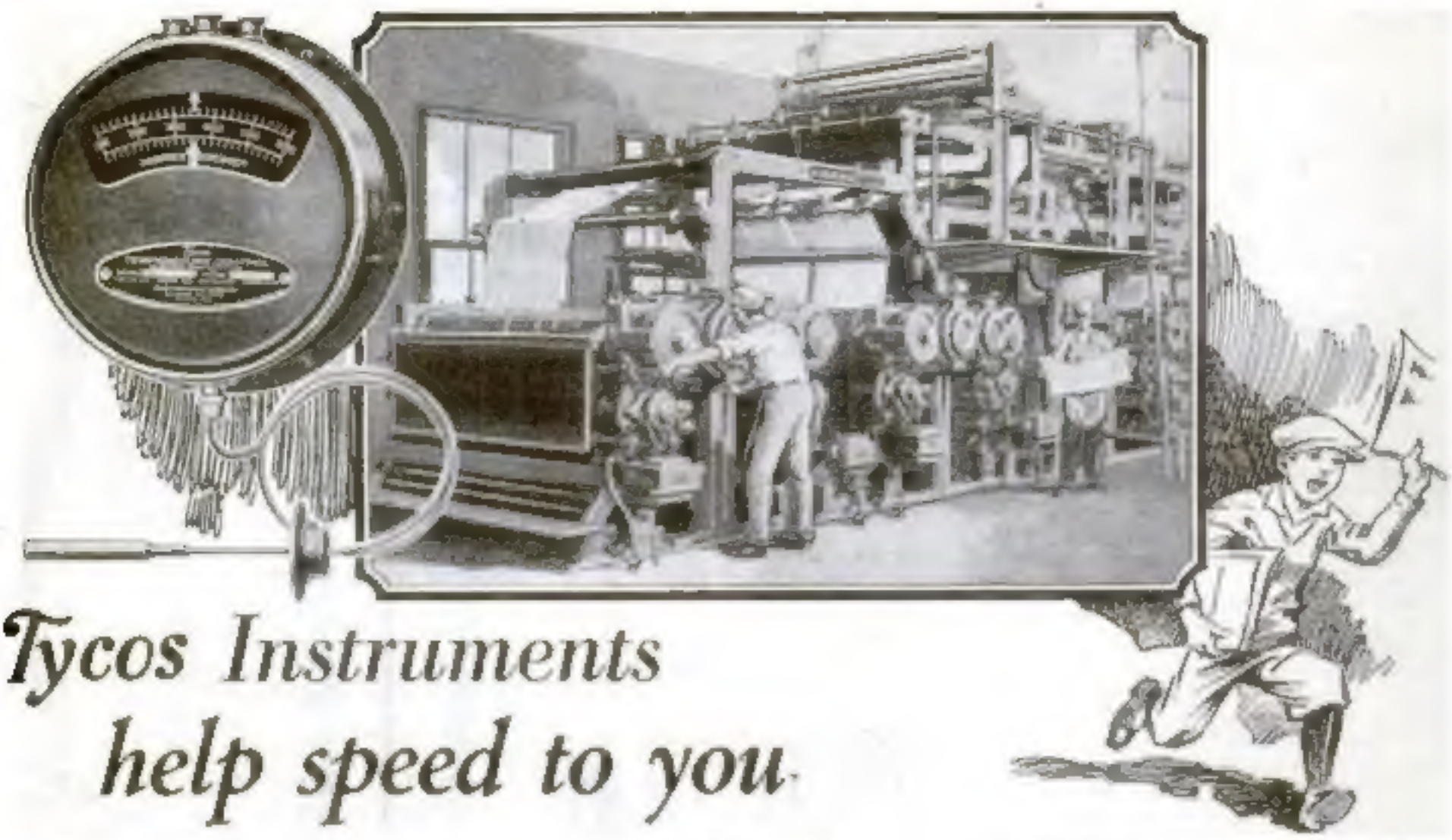

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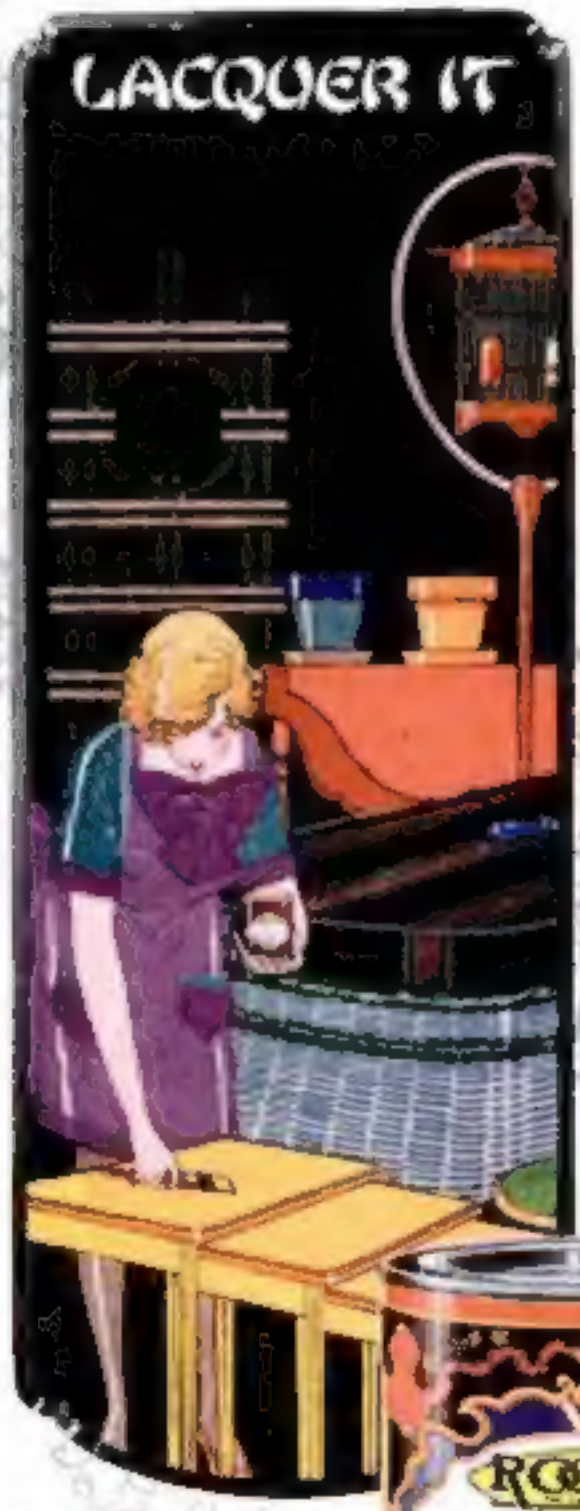

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WHY the Ciné-Kodak *takes such Wonderful* Home Movies

This is Ciné-Kodak Model B with f. 1.9 lens, the fastest lens supplied as stock equipment with any home movie camera. Two other lens equipments are available — f. 6.5 and f. 3.5.

Here are some reasons *for its astonishing results*

IF you were asked to name the one organization in the entire world which, in your opinion, knew most about photography, wouldn't your answer surely be the Eastman Kodak Company?

And wouldn't you expect that the company which for years had made the finest cameras for "still" photography would make the finest cameras for movies?

That's why people everywhere rightly regard the Ciné-Kodak as the last word in amateur movie equipment. Specifically, it is the following features that make it so:

(1) Next to the lens mount is a semi-automatic diaphragm scale, a permanent part of the camera, which tells you just what to do under each light condition. (2) There is the usual eye-level sight finder but in the Ciné-Kodak it is so placed that you don't need to squint or remove hat or glasses. In addition, (3) there is a waist-level reflecting finder, invaluable when taking pictures of children or pets.

(4) The winding handle for the motor is permanently attached. You can't lose it or forget it. The very shape of the Ciné-Kodak is convenient; (5) it is easy to carry and (6) can be rested anywhere.

Because of this and because (7) the release can be locked in running position, you can actually take movies of yourself. (8) Loading and unloading are done with the greatest ease. There are no tight fits and the film is also completely protected. Everything is so arranged as to make threading the film and cleaning the mechanism simplicity itself. Moreover, no pains have been spared to make this mechanism strong and durable as well as convenient.

(9) The materials used are of the finest, the gate, for example, being chromium-plated, and (10) the camera itself handsomely covered with leather.

(11) **Ciné-Kodaks are Eastman-made throughout. The lenses are made *for* the camera, not fitted *to* it and (12) not only is this equipment backed by the Kodak reputation but the user has the benefit of Eastman service, world-wide in scope.**

(13) Ciné-Kodak embodies Eastman's forty years' experience in devising easy picture making methods for the amateur. Unbiased by the precedents and prejudices of professional cinema camera design, the men who made still photography so easy have now made home movie making equally simple for you. The result is that the Ciné-Kodak is the simplest home movie camera.

(14) As an example of this simplicity, the *f.* 6.5 and *f.* 3.5 models require no focusing. And while the *f.* 1.9 pictured above, because of its extreme speed, does require focusing, this is easily accomplished by a simple twist of the lens barrel.

And, now, finally, add to these fourteen points of excellence a fifteenth. Instead of being much higher in price than other cameras of its type, the Ciné-Kodak (15) actually costs less. So see your Kodak dealer for interesting demonstration and clip coupon below for booklet.

EASTMAN KODAK COMPANY
Dept. PS-6, Rochester, N. Y.

Please send me, FREE and without obligation, the booklet telling me how I can easily make my own movies.

Name.....

Address.....